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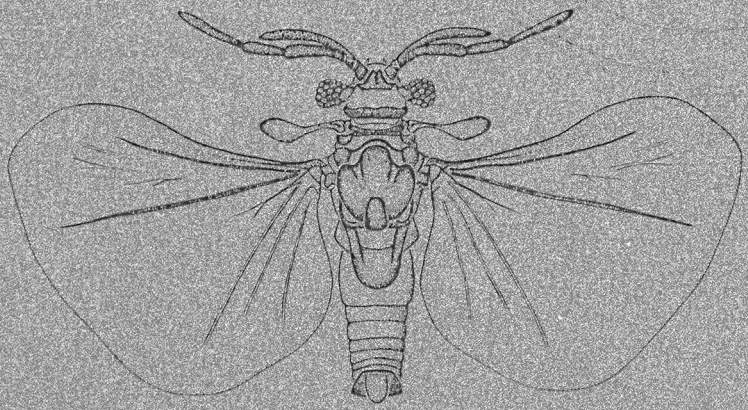

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Enquiries relating to the Society should be directed to the Honorary Secretary, Entomological Society of Queensland, C/- Department of Entomology, University of Queensland, Brisbane, Qld, 4072.

Cover: Strepsiptera are entomophagous parasitoids which exhibit extreme sexual dimorphism, the males being winged and free-living while the wingless females are permanently endoparasitic in the host. The specimen illustrated belongs to the family Stylopidae and are parasites of Vespidae, Sphecidae and Apoidea. Illustration by Yanni Martin.

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NEW LARVAL FOOD PLANTS FOR SOME BUTTERFLIES (LEPIDOPTERA) FROM NORTHERN AND CENTRAL QUEENSLAND, AUSTRALIA

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Abstract

An annotated list of 54 species of new larval food plants for 33 butterfly species from northern and central Queensland is presented. An additional six plant species are listed which confirm recent or poorly documented records. Thirteen (21%) of the recorded plant species are based on oviposition records only and the suitability of these plants may require further observation. For some species of Lycaenidae, life history and biological notes of the early stages and attendant ants are given.

Introduction

The following list of butterfly larval food plants is based on field observations and rearing of the early stages from northern and central Queensland during 1989-1995. The new records are in addition to those reported in several recent papers on larval food plants for the region (Valentine 1988, Sankowsky 1991, Braby 1995) and contribute to the growing list of Australian butterfly food plants (see Common and Waterhouse 1981, Dunn and Dunn 1991). The list is presented in annotated form, summarising details of locality, date, immature stage, numbers and rearing data. In some cases, details on the biology and behaviour of the early stages are given where these appear to have been poorly documented, particularly for the Lycaenidae. Several food plant records are based on oviposition observations only, that is, a female was observed to lay an egg(s) on a particular plant and their suitability may require confirmation.

Butterfly specific nomenclature follows that of Nielsen *et al.* (1996). Introduced plants are designated by an asterisk (*).

HESPERIIDAE

***Euschemon rafflesia* (W.S. Macleay)**

Tetrasyndra pubescens (Benth.) Perkins (Monimiaceae). 9 km W of Paluma, 12.iv.1995. Eggs and numerous larvae, in various instars, were found on several plants growing in tall open forest dominated by *Eucalyptus grandis* W.Hill.

***Telicota colon* (Fabricius)**

Ophiuros exaltatus (L.) Kuntze (Poaceae). Mt Cleveland, 3.iii.1991. One final instar larva was collected from a leaf shelter and reared; a female emerged on 22.iii.1991 after 14 days pupation.

Ischaemum australe R.Br. (Poaceae). 9 km SSE of Cardwell, 7.iii.1992. A female was collected after laying a single egg on a young green leaf in *Melaleuca* swampland.

PIERIDAE

***Delias argenthona* (Fabricius)**

Amyema cambagei (Blakely) Danser (Loranthaceae). Ollera Creek, 10 km NW of Rollingstone, 17.viii.1991. One pupa (parasitised) was found attached to a stem of *Allocasuarina cunninghamiana* Miq. directly beneath clumps of the mistletoe which grew abundantly on the host. No other mistletoe species was present on *A. cunninghamiana* or in the immediate vicinity, the host tree being isolated from others by more than 15 m. Dunn (1995) recently reared fourth instar larvae to adult on this mistletoe.

Amyema miquelii (Lehm. ex Miq.) Tieghem (Loranthaceae). James Cook University, Townsville; Damper Creek, 14 km SSE of Cardwell. All stages were commonly found and reared between March and June on plants parasitising *Eucalyptus platyphylla* F.Muell. in savanna woodland. This plant was not listed by either Common and Waterhouse (1981) or Dunn and Dunn (1991), but the above observations agree with those of Edwards (1948), Fox (1995) and Dunn (1995) who reported *A. miquelii* as a food plant in Queensland near Mitchell, Leyburn and Brisbane.

Amyema sanguinuem (F.Muell.) Danser (Loranthaceae). James Cook University, Townsville, vi-vii.1990, 20.iii.1991, 22-24.iv.1991. Three egg clusters and nine larvae were found on this mistletoe parasitising *Eucalyptus platyphylla* and *E. tereticornis* Smith. Four larvae were reared to adults.

Dendrophthoe glabrescens (Blakely) Barlow (Loranthaceae). Townsville. Frequently used in suburban areas, particularly those clumps growing on ornamental trees of *Callistemon viminalis* (Gaertner) G.Don. McLean (1993) and Moss and Lithgow (1994) recently recorded this species as a larval food plant at Cooktown and near Chinchilla, Queensland, respectively.

Diplatia furcata Barlow (Loranthaceae). 9 km SSE of Cardwell, 14.vi.1992. Twelve eggs were found on foliage of this mistletoe parasitising *Melaleuca viridiflora* Gaertner in paperbark swampland.

Scrubby Creek, 24 km SE of Cardwell, 29.viii.1992. Four larvae (instars IV and V) were found on foliage of this mistletoe parasitising *Melaleuca viridiflora* in paperbark woodland.

***Delias mysis* (Fabricius)**

Dendrophthoe falcata (L.f.) Ettingsh. (Loranthaceae). Cardwell, 8.vi.1992. A cluster of 11 eggs was found on a leaf of this mistletoe parasitising ornamental *Callistemon viminalis*. W.A. Travers (pers. comm.) has noted that the larvae, and sometimes those of *D. nigrina*, frequently utilise this plant at Cardwell but only during the winter months. The mistletoe illustrated and recorded for *D. mysis* at Kuranda by McCubbin (1971) is almost certainly this species.

***Delias nigrina* (Fabricius)**

Dendrophthoe falcata (Loranthaceae). Cardwell. See notes under *D. mysis*. The mistletoe illustrated and recorded for *D. nigrina* at Kuranda by McCubbin (1971) is almost certainly this species.

***Belenois java* (Linnaeus)**

Capparis canescens DC. (Capparaceae). Not listed by Common and Waterhouse (1981), this species was recorded by Manski (1960) and more recently by Forster (1991) from the coastal and subcoastal areas of Queensland. I also recorded the early stages on this food plant at three inland localities in savanna woodland:

30 km W of Mt. Surprise, 9.x.1991. Three mid instar larvae.

Running River, Hidden Valley, 14.x.1991. Numerous eggs were found in clusters of up to 30 on young terminal shoots.

Leichhardt Range, 25 km (by road) S of Burdekin Falls, 26.iv.1992. 15 pupal exuviae.

***Cepora perimale* (Donovan)**

Capparis canescens (Capparaceae). Mt. Kulburn, 20 km NW of Townsville, 11.ix.1993. One final instar larva and one pupa were found attached to the upperside of leaves in savanna woodland.

NYMPHALIDAE

***Polyura sempronius* (Fabricius)**

Acacia mearnsii De Wild. (Mimosaceae). Nelly Bay, Magnetic Island, 18.xi.1989. One late instar larva and one pupa (parasitised) were collected from foliage in a suburban garden by R. Braley. *A. mearnsii* is not indigenous to the island.

Albizia canescens Benth. (Mimosaceae). Cape Cleveland, 12.viii.1990. One egg and two larvae (instars I and IV) were found on the upperside of foliage of a 1.5 m high plant in eucalypt open forest.

***Vanessa kershawi* (McCoy)**

Helichrysum rupicola DC. (Asteraceae). 8 km W of Paluma, 22.i.1994, 12.05 pm. A female was observed to lay a single egg on a leaf at a roadside verge in tall open forest.

***Junonia villida* (Fabricius)**

Hyptis suavolens (L.) Poit. (Lamiaceae). Mt. Stuart, Townsville, 12.ii.1991. One larva was found feeding on foliage of herb growing amongst rocks at summit.

**Ruellia* sp. (Acanthaceae) - Hermit Park, Townsville, 20.xi.1992. A female was observed ovipositing on the underside of leaves on recently germinated plants following rainfall in a suburban garden.

**Stachytarpheta jamaicensis* (L.) Vahl (Verbenaceae). James Cook University, Townsville,.i.1992. One larva was collected and reared to adult by M. Overton.

LYCAENIDAE

***Paralucia pyrodiscus* (Doubleday)**

Bursaria incana Lindley (Pittosporaceae). Walsh River, 11 km WNW of Herberton, 31.v.1991, 19.viii.1992. All stages and attendant ants, *Notoncus gilberti* Forel, were collected from a localised colony (Wood 1992) in savanna woodland at 750 m. The early stages were associated only with very small stunted plants (<0.8 m high, frequently ≤0.4 m high) which had juvenile leaves only. Eggs were found only on the trunk at the base of the plant; larvae and pupae were below ground against the main trunk with attendant ants. One male emerged in captivity on 4.ix.1992 after a pupal duration of 15 days.

19 km W of Paluma, 28.viii.1993. All stages of a small localised colony and attendant ants, *N. gilberti*, were located on small stunted plants (<0.5 m high) on granitic soils in savanna woodland.

Citriobatus spinescens (F.Muell.) Druce (Pittosporaceae). Bauhinia Creek, 20 km ESE of Duaringa, 6, 8.ix.1990. Eggs, larvae (many of which were parasitised), one pupa and attendant ants, *N. gilberti*, were collected from a small colony in savanna woodland on alluvial soils adjacent to a creek. The early stages were associated with very small plants (<0.5 m high) having juvenile leaves only. Eggs were found only at base of plants, mostly on the main trunk but also on leaf litter. No evidence of adult or early stages was found during subsequent visits on 18.vi.1991 or 31.iii.1992 following the January 1991 floods (Cyclone Joy).

***Hypochrysops ignitus* (Leach)**

Acacia mangium Willd. (Mimosaceae). Porters Creek, 16 km SSE of Cardwell, 7.iii.1994. Six early to mid instar larvae with attendant ants, *Papyrius* sp., were located on foliage of a 1.0 m high plant in the ecotone between gallery rainforest and paperbark woodland.

***Hypochrysops digglesii* (Hewitson)**

Amyema bifurcatum (Benth.) Tieghem (Loranthaceae). Cape Pallarenda, 8 km NW of Townsville, 11.v.1991. Two eggs were located on leaves of mistletoe parasitising *Eucalyptus tessellaris* F.Muell. Larval feeding scars and attendant ants, *Crematogaster* sp., were also evident.

Cranbrook, Townsville, 30.vi.1992. Several empty egg shells, three mid instar larvae and attendant ants, *Crematogaster* sp., were collected from foliage of the mistletoe parasitising *E. tessellaris* in a parkland of remnant savanna woodland.

Amyema miquelii (Loranthaceae). James Cook University, Townsville, iii-iv.1991. All stages and attendant ants, *Crematogaster* sp., were found on a large clump of mistletoe parasitising *Eucalyptus tereticornis*. Several adults were reared from larvae or pupae. Most eggs were laid singly on the leaves of the mistletoe but others were on stems and flowers and some on the eucalypt leaves of the host tree amongst the mistletoe. Early instar larvae were noted to eat only the epidermis of the leaf whereas later instar larvae tended to consume the whole leaf. The early instar larvae did not retreat into shelters, typical of later instar larvae, but remained exposed on leaves during the day, usually one or sometimes two larvae rested on a leaf. Closer examination of these early instar larvae revealed each had eaten a relatively deep but narrow longitudinal groove through the leaf; they remained in this groove so that the body was at least half embeded in the leaf. Only later instar larvae were observed to construct the typical twisted shelters, made by folding a leaf along the groove and then twisting or curling the leaf with silk. Larvae fed most actively at night but all instars also fed during the day. Pupae were usually found in twisted leaf shelters, but sometimes under loose bark of the host tree near the mistletoe clump, or under bark on the ground at the base of the host tree near the attendant ants' nest (*c.* 3 m from mistletoe clump).

Amyema sanguineum (Loranthaceae). James Cook University, Townsville, 20.ii.1992. One final instar larva with attendant ants, *Crematogaster* sp., was collected from a leaf shelter; it pupated on 2.iii.1992 and a female emerged 10 days later.

Dendrophthoe homoplastica (Blakely) (Loranthaceae). James Cook University, Townsville, iv.1991, 10.xii.1992. All stages and attendant ants, *Crematogaster* sp., were recorded on this mistletoe parasitising *Callistemon viminalis*. Several larvae were reared to adult in captivity, the pupal stage varying from 16 to 20 days.

***Ogyris zosine* (Hewitson)**

Amyema bifurcatum (Loranthaceae). Leichhardt Range, 14.5 km (by road) S of Burdekin Falls, 26.iv.1992. Eight late instar larvae and two parasitised larvae were found within a nest of *Camponotus* sp. at the base of a large *Eucalyptus papuana* F.Muell.

37 km S of Lynd Junction, 4.v.1992. One empty pupal shell was collected under loose bark at the base of a small *E. papuana* supporting a clump of mistletoe. Adults and food plant were common in the area.

42 km NE of Lynd Junction, 6.v.1992. Ten larvae, of various instars, one pupa and attendant ants, *Camponotus* sp., were located at the base of *E. papuana* with clumps of mistletoe. Most larvae were in ant galleries in the soil or beneath leaf litter and debris but some were above the ground under loose bark of the host tree. A female was observed in the mid afternoon

displaying characteristic pre-oviposition behaviour which involved trailing the abdomen over the main trunk of the mistletoe.

Stuart, Townsville, 25.vii.1993. Two pupae and attendant ants, *Camponotus* sp., were collected from beneath a rock at the base of a *Eucalyptus tessellaris* supporting clumps of the mistletoe.

Amyema cambagei (Loranthaceae). Ollera Creek, 10 km NW of Rollingstone, 12.iii.1992. Two mid instar larvae and attendant ants, *Camponotus* sp., were found in a hollow of a branch of *Allocasuarina cunninghamiana* which supported a large clump of the mistletoe, the foliage of which had been extensively eaten; the mistletoe grew in abundance on the host tree and no other species of mistletoe was present. The larvae accepted foliage of *A. cambagei* in captivity. A female was observed displaying characteristic pre-oviposition behaviour but did not appear to oviposit; two females were observed displaying similar behaviour on the same tree several months earlier on 20.viii.1991. The record confirms the listing in Common and Waterhouse (1981), which makes only vague reference to this species as a larval food plant.

Amyema miquelli (Loranthaceae). James Cook University, Townsville. This mistletoe was utilised commonly during the wet season, especially clumps parasitising *Eucalyptus platyphylla*; many adults were reared from larvae or pupae, the larvae being attended by *Camponotus* sp. ants

Dendrophthoe glabrescens (Loranthaceae). Ollera Creek, 10 km NW of Rollingstone, 26.i.1992. One mid instar larva was collected from the ant nest of *Camponotus* sp. at the base of a small *Melaleuca* sp. supporting a large clump of the mistletoe. It was reared in captivity on the leaves of *D. glabrescens* and pupated on 16.iii.1992, a female emerged 12 days later.

***Ogyris aenone* (Waterhouse)**

Diplatia furcata (Loranthaceae). Scrubby Creek, 24 km SE of Cardwell, 8.x.1989. One early instar larva was recorded on a leaf of this mistletoe parasitsing *Melaleuca viridflora.*

Porters Creek, 16 km SSE of Cardwell, 15.vi.1992, 30.viii.1992. Three empty pupal shells were collected from within a hollow dead branch and under loose bark of *M. viridflora*; they were found next to clumps of the mistletoe, the leaves of which showed characteristic signs of past larval feeding and which was parasitising the host tree. No other mistletoe species were growing on the host tree.

***Ogyris iphis* (Waterhouse & Lyell)**

Amyema bifurcatum (Loranthaceae). 21 km W of Paluma, 19.ii.1994. Five final instar larvae with attendant ants, *Froggatella kirbii* (Lowne), were collected under loose bark near the base of a *Eucalyptus citriodora* Hook. supporting several clumps of the mistletoe. No other mistletoe species was

parasitising the host tree. The larvae were reared in captivity to adults with five females emerging in iii.1994.

Dendrophthoe glabrescens (Loranthaceae). 15 km W of Paluma, 23.vi.1990. Two final instar larvae with attendant ants, *F. kirbii,* were collected under loose bark of a branch of *Eucalyptus acmenoides* supporting the mistletoe in open forest. The larvae were reared to adults, emerging in viii.1990, with the pupal stage varying from 19 (male) to 20 (female) days. Occasionally the pupae produced a series of audible clicks.

***Jalmenus eichhorni* Staudinger**

Acacia holosericea G.Don (Mimosaceae). Forty Mile Scrub, 25.ii.1994. All stages and attendant ants, *Iridomyrmex sanguineus* Forel, were collected from a colony (discovered by G.A. Wood) on regenerating plants at a roadside verge disturbed by recent road grading activities.

***Deudorix epijarbas* (Moore)**

Salacia chinensis L. (Hippocrateaceae). Garners Beach, 8.vi.1992. One female was reared from a larva collected from within fruit. The larva pupated on 25.vi.1992 and a female emerged 18 days later. Before pupation the larva left the fruit and pupated between strips of bark placed in a breeding box.

***Candalides absimilis* (C. Felder)**

Pongamia pinnata (L.) Pierre (Fabaceae). Damper Creek, 14 km SSE of Cardwell, 30.xi.1991. A female was collected after laying five eggs on young terminal leaves of very small seedlings (<150 mm high) along the edge of gallery rainforest during the mid-morning. All eggs were laid singly and three of these hatched two days later. On 6.xii.1991 one first instar larva and one mid instar larva were found on the underside of leaves. On 9.x.1993 another larva was collected from the underside of a leaflet of regenerating foliage; it was reared in captivity but would only eat the new soft growth. The larva pupated on 17.x.1993 and a female emerged 10 days later.

Atalaya salicifolia (A.DC.) Blume (Sapindaceae). The Pinnacles, Hervey Range, 27.i.1992. One larva was collected from flower buds by J.M. Billington.

***Candalides erinus* (Fabricius)**

Cassytha pubescens R.Br. (Lauraceae). 10 km N of Nebo, 10.ix.1990. Numerous eggs were found on the softer young vines which grew in abundance over *Melaleuca nervosa* (Lindley) Cheel. Adults were common in the immediate vicinity and one final instar larva was collected by vigorously shaking the host tree.

9 km SSE of Cardwell, 27.xi.1991. Several eggs were located on the new growth of a large vine which grew profusely over *M. nervosa* in paperbark swampland; adults were common in the area.

Mt. Kulburn, 20 km NW of Townsville, 11.ix.1993. One empty pupal shell was recovered from a vine growing in savanna woodland.

***Nacaduba berenice* (Herrich-Schaffer)**

Atalaya salicifolia (Sapindaceae). The Pinnacles, Hervey Range, 27.i.1992. A female was observed by J.M. Billington ovipositing on new terminal foliage. Three larvae, associated with numerous small black ants, were collected from flower buds.

Guioa acutifolia Radlk. (Sapindaceae). Bluewater State Forest, 22 km (by road) SW of Bluewater, 26.xii.1991. Two females were observed ovipositing on new terminal leaves in tall open forest with a rainforest understorey. Three empty eggs and one early instar larva were also found on the new growth. All eggs were laid singly.

***Nacaduba biocellata* (C. & R. Felder)**

Acacia bidwillii Benth. (Mimosaceae). James Cook University, Townsville, 10.xi.1990. Two larvae collected from flower buds were reared to pupation. Two males emerged on 22, 26.xi.1990, the pupal stage being eight days in captivity.

***Psychonotis caelius* (C. Felder)**

Alphitonia petriei Braid (Rhamnaceae). Bluewater State Forest, 34 km (by road) SW of Bluewater, 27.iii.1993. Two females were observed during the early afternoon ovipositing on small plants (<0.5 m high) in rainforest; a further three eggs were located on a single leaf. All eggs were laid singly on the underside of the leaves, along the edge of a vein. One egg hatched about four days after being laid.

12 km (by road) W of Kennedy, 27.ii.1994. One final instar larva was collected from the underside of a leaf of small plant (c. 3 m high) in a gap in rainforest. It pupated on 4.iii.1994 and a male emerged eight days later. Jackson (1996) recently recorded this species as a food plant at Paluma.

***Theclinesthes miskini* (T.P. Lucas)**

Acacia aulacocarpa Benth. (Mimosaceae). Paluma, 17.iii.1992. A female was observed ovipositing along the edge of upland rainforest. The eggs were laid on new softer foliage of a branch, about 3 m above the ground, which had numerous small black ants.

Acacia crassicarpa Benth. (Mimosaceae). Near Damper Creek, 14 km SSE Cardwell, 1, 11.iii.1992. Eggs and several larvae, in various instars, were found on foliage of two small plants (0.4 m, 0.6 m high) in eucalypt open forest. Larvae on each plant were attended by different species of unidentified ants.

Acacia mangium Willd. (Mimosaceae). Damper Creek, 14 km SSE Cardwell, 9.ii.1990. Four larvae with attendant ants were found on a small

plant (c. 0.5 m high) along the margin of gallery rainforest. On 12.xii.1991 eggs, numerous larvae and attendant ants were found on two additional plants, also small (<1.0 m high). The eggs had been deposited singly on terminal shoots and stems. The larvae were feeding mostly on the phyllodes but two were feeding on fleshy galls. In captivity larvae were reared to adults on both phyllodes and galls; the pupal stage lasting eight days.

Eucalyptus clarksoniana D.J. Carr & S.G.M. Carr (Myrtaceae). Near Damper Creek, 14 km SSE Cardwell, 2.xii.1991. A female was observed to lay two eggs on the stem of a very small plant (c. 100 mm high) regenerating in eucalypt open forest after fire two months earlier. Small black ants were present. On 4.iii.1992 another female was observed to lay a single egg on young soft terminal foliage of another small plant (0.5 m high). Numerous small black ants were noted attending leaf hoppers. On 11.iii.1991 a third female was observed ovipositing on the stems, axils and young terminal leaves of another very small plant (c. 150 mm high). On this occasion, however, no ants were present.

Eucalyptus tessellaris (Myrtaceae). Ollera Creek, 10 km NW of Rollingstone, 14.iv.1995. A female was disturbed after laying eight eggs on leaves and axils of a small plant (0.4 m high) in an open cleared area. All eggs had been laid singly.

***Theclinesthes onycha* (Hewitson)**

Cycas media R.Br. (Cycadaceae). Forster and Machin (1994) made vague reference to this specioes as a possible food plant. In the Cardwell district, females were found to commonly use this species in lowland eucalypt open forest. They laid numerous eggs but only on new, soft fronds arising from apex of the trunk, especially (but not always) on plants regenerating after fire. The larvae fed only on new, soft growth, sometimes causing considerable damage such that regeneration would be delayed until the next season; the fronds of such plants had a scorched sticky appearance. Larvae fed at night or sometimes very late in the afternoon, retreating by day to hide at the base of new fronds. They were attended by at least two species of ants, including *Camponotus* sp. The pupae were well-hidden and usually found at the base of older fronds some distance from the apex of the trunk. The pupal duration in March was six days.

Cape Upstart National Park, 28.ix.1991. Eggs and larvae were located on new developing fronds, in similar circumstances to those described above.

***Theclinesthes sulpitius* (Miskin)**

Suaeda australis (R.Br.) Moq. (Chenopodiaceae). Cleveland Bay, Townsville, 25.viii.1991. Eggs and an early instar larva were collected from terminal leaves and several late instar larvae were found resting on dry sand beneath the food plant, which formed a dense mat in saltmarsh habitat. One pupa was also found beneath the plant, concealed in the crevice of driftwood.

Adults were locally common, frequently alighting on the plant. Several adults were reared from larvae in captivity, the pupal duration in September being eight days.

Ross River, Townsville Golf Course, 2, 4.iv.1993. All stages were found commonly in saltmarsh habitat along a river flat. Eggs were found singly on terminal foliage, the larvae mostly on leaves. A pre-pupa and empty pupal shells were found beneath the plant attached to dead sticks, beneath rocks, on loose sand or to branches of the food plant. The pupal duration was six days in April. The habitat, including *S. australis*, was noted to be periodically inundated by saline water from high tides.

***Jamides phaseli* (Mathew)**

Indigofera pratensis F.Muell. (Fabaceae). Cardwell, 27.ii.1992. Two final instar larvae were collected from flowers in eucalypt open forest. A male emerged on 8.iii.1992 and a female on 9.iii.1992, the pupal duration being six days.

***Catochrysops panormis* (C. Felder)**

Galactia tenuiflora (Sprengel) Wight & Arn. (Fabaceae). Near Damper Creek, 15 km SSE of Cardwell, 11.iii.1992. A female was observed to lay two eggs on young flower buds of a creeper growing over rocks in eucalypt open forest. The eggs were concealed deep inside the calyx.

***Lampides boeticus* (Linnaeus)**

**Crotalaria goreensis* Guillemin & Perrottet (Fabaceae). Cardwell, 25.iv.1990. A female was observed to lay a single egg on a flower bud at a roadside verge in open forest.

Campaspe River, 17.5 km NE of Pentland, 29.iv.1992. Numerous eggs were found on flower buds and two mid instar larvae were found feeding inside the buds. Five final instar larvae (later found to be parasitised) were collected from the base of the trunk in river sand.

Crotalaria mitchellii Benth. (Fabaceae). Blackdown Tableland (23°42'S, 149°07'E), 1.iv.1992. Numerous eggs and one final instar larva were found on the flower buds in savanna woodland on alluvial soil.

**Crotalaria novae-hollandiae* DC. (Fabaceae). Junction Creek, 9 km W of Mt. Surprise, 6.v.1992. Numerous eggs were located on flower buds along the edge of a watercoarse in river sand. Adults were common.

**Indigofera suffruticosa* Miller (Fabaceae). Townsville, 9.viii.1991. A female was observed to lay a single egg at the base of a flower at a roadside verge.

***Zizeeria karsandra* (Moore)**

Glinus oppositifolia (L.) R.DC. (Molluginaceae). Campaspe River, 17.5 km NE of Pentland, 29.iv.1992. Numerous eggs and one mid instar larva were

found on the underside of leaves in the sand of a dry river. Adults were very common.

***Famegana alsulus* (Herrich-Schaffer)**

Galactia tenuiflora (Fabaceae). James Cook University, Townsville, 6.iii.1994. A female was observed ovipositing on terminal flower buds of a creeper in savanna woodland. All eggs were laid singly.

Indigofera pratensis. Cardwell, 27.ii.1992. Two final instar larvae were collected from flowers in eucalypt open forest. One larva pupated on 1.iii.1992 and a male emerged six days later.

Ilbilbie, 27.iii.1992. One final instar larva collected feeding on flowers in eucalypt open forest. A male emerged on 12.iv.1992.

Vigna lanceolata Benth. (Fabaceae). James Cook University, Townsville, 10.iii.1991. A female was observed to lay a single egg on a developing leaf bud in savanna woodland.

***Zizula hylax* (Fabricius)**

Dipteracanthus australasicus ssp. *corynothecus* (Benth.) R. Brown (Acanthaceae) (voucher AQ 625003, Queensland Herbarium). 8 km S of Wandoan, 16.iii.1994. Three females were observed to lay four eggs at a roadside verge in remnant woodland. The eggs were laid singly on the flower buds or corolla and sepals of expanded flowers. Many other eggs were found on flowers. Examination of older fruits revealed frass and signs of recent feeding activity but no larvae or pupae were found. Adults of both sexes were very common near the plants.

***Euchrysops cnejus* (Fabricius)**

Macroptilium atropurpureum (DC.) Urban (Fabaceae). Harvey Range, approx. 40 km WSW of Townsville, 21.i.1990. Numerous eggs were found on flower buds and several larvae found feeding inside the flowers of a creeper growing over rock scree in savanna woodland. Adult females were common, flying close to or settling upon the leaves.

James Cook University, Townsville, 4.ii.1992. A female was observed ovipositing on a creeper in a disturbed area of savanna woodland. All eggs were laid singly on stems, stipules, flower buds and the upper and underside of leaflets.

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the attendant ants of lycaenid species; and Ted Edwards, Andrew Atkins and Max Moulds kindly commented on a draft of the manuscript. Jeremy Billington, Graham Wood, Bill Travers, Max Overton and Rick Braley kindly provided or drew my attention to several food plant records.

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RECORDS OF INSECTS ASSOCIATED WITH *ACACIA DEALBATA* LINK. IN TASMANIA

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Abstract

New records of insects associated with *Acacia dealbata* Link. in Tasmania are presented, based on records of the Tasmanian Forest Insect Collection. Previously published records are included, making a total of 97 species from 36 families. Species of Cerambycidae, Curculionidae, Chrysomelidae, Psyllidae and Geometridae are most common on silver wattle.

Introduction

Silver wattle, *Acacia dealbata* Link., is the most common bipinnate wattle species growing in Tasmania (Costermans 1991). Considerable research interest has developed in it as a resource for pulpwood and sawlog production, as a weed in plantations of eucalypts and softwoods in Australia and as an invasive weed overseas.

Several researchers have surveyed and listed insect species associated with *A. dealbata* in the mainland states of Australia but have included few records from Tasmania. Van den Berg (1982a, b, c) collected extensively throughout the mainland for biological control agents for use in South Africa, where invasion into native vegetation and plantations was a major problem (van den Berg 1977); he listed 70 species attacking *A. dealbata*. New (1979, 1983) examined seed predation and the abundance of Coleoptera on acacias in Southern Victoria and reported that 115 morphospecies of Coleoptera had been collected in Victoria on *A. dealbata* during a three year period. Hawkeswood (1994) reviewed the biology of chrysomelids associated with *Acacia* and Webb (1994) listed the wood inhabiting insect fauna of some *Acacia* species.

Research conducted in Tasmania on the fireblight beetle, *Pyrgoides orphana* Erichson (Elliott 1978), detailed the life history and effects on growth of planted silver wattle. Bashford (1991) presented records of wood-boring Coleoptera and associated insects reared from *A. dealbata* billets from several sites in Tasmania.

This report includes only those species reared either from timber samples, from galls or feeding on foliage for at least some stage of their life cycle. Many species of Coleoptera collected have been omitted due to doubt as to their feeding status on *A. dealbata*. Consequently this list of injurious insects cannot be considered complete.

Results

The following species list (Table 1) has been compiled over a period of 20 years. It includes records from regular collections at long term survey sites on the East Coast (Elliott and Bashford, unpublished data) and incidental collecting throughout the range of *A. dealbata* in Tasmania.

Specimens of all species listed are lodged in the Tasmanian Forest Insect Collection, Forestry Tasmania.

Table 1. Insects Associated with *Acacia dealbata* in Tasmania.

A. Species injurious to *Acacia dealbata.*	References *
COLEOPTERA	
Cerambycidae	
Ambeodontus pilosus (Pascoe)	4, 5
Amphirhoe decora Newman	4, 5
Ancita crocogaster (Boisduval)	3, 4, 5
Ancita marginicollis (Boisduval)	4, 5
Aphneope quadrimaculator Poll	5
Bethelium signiferum (Newman)	4, 5
Illaena exilis Erichson	4, 5
Mecynopus cothurnatus Erichson	4, 5
Notoceresium impressiceps Blackburn	5
Phacodes personatus (Erichson)	5
Probatodes plumula (Newman)	3, 4, 5
Rhinophthalmus nasutus (Shuckard)	4, 5
Stenocentrus suturalis (Olivier)	4, 5
Syllitus grammicus (Newman)	4, 5
Tessaromma undatum Newman	NR
Zoedia divisa Pascoe	5
Curculionidae	
Belus bidentatus (Donovan)	4, 5
Belus bimaculatus Pascoe	4, 5
Orthorhinus cylindrirostris (Fabricius)	3, 4, 5
Pachyura cinerea (Blanchard)	4, 5
Pentamimus australis (Erichson)	5
Rhinotia haemoptera Kirby	NR
Saccolaemus carinicollis (Lea)	NR
Saccolaemus sp.	5
Bostrychidae	
Xylobosca bispinosa (Macleay)	5
Xylobosca canina (Blackburn)	5
Chrysomelidae	
Calomela curtisi (Kirby)	4
Calomela sp.	3
Dicranosterna immaculata (Marsham)	4
Haltica pagana Blackburn	NR
Platycolaspisaustralis Blackburn	NR
Pyrgoides orphana (Erichson)	2, 3, 4

Table 1. (continued)

Pyrgoides sp.A	NR
Pyrgoides sp.B	NR
Pyrgoides sp.C	NR
Lyctidae	
Trogoxylon ypsilon (Lesne)	5
Buprestidae	
*Cisseis*pauperula (Kerremans)	5
Melobasis purpurascens (Fabricius)	5
Lycidae	
Metriorrhynchus rhipidius MacLeay	NR
Bruchidae	
Melanterius sp.	3
Scarabaeidae	
Diphucephala colaspidoides (Gyllenhal)	1, 3, 4
HEMIPTERA	
Psyllidae	
Acizzia acaciaedealbatae (Froggatt)	NR
Acizzia conspicua Tuthill	NR
Acizzia sp. C	NR
Acizzia sp. D	NR
Acizzia sp. E	NR
Acizzia sp. G	NR
Acizzia sp. J	NR
Acizzia sp. K	NR
Phellopsylla sp. B	NR
Cicadidae	
Cicadetta torrida (Erichson)	NR
Psaltoda moerens (Germar)	NR
Flatidae	
Siphanita acuta (Walker)	NR
Euphanta munda (Walker)	NR
Membracidae	
Ceraon tasmaniae (Fairmaire)	NR
Pseudococcidae	
Melancoccus albizziae (Maskell)	NR
Tingidae	
Epimixia sp.	NR
HYMENOPTERA	
Pteromalidae	
Trichilogaster trilineata (Cameron)	3

Table 1. (continued)

LEPIDOPTERA	
Anthelidae	
Anthela addita Walker	NR
Anthela connexa (Walker)	3
Anthela nicothoe (Boisduval)	3
Anthela ocellata (Walker)	NR
Anthela sp.	NR
Pterolocera sp.	4
Arctiidae	
Asura cervicalis Walker	4
Lymantriidae	
Acyphas leucomelas (Walker)	3, 4
Acyphas sp.	4
Teia anartoides Walker	3, 4
Geometridae	
Boarmia sp.	4
Chlenias sp.	NR
Chlorocoma dichloraria (Guenee)	4
Dichromodes ainaria Guenee	4
Microdes squamulata Guenee	3, 4
Thalaina inscripta Walker	3, 4
Oecophoridae	
Chryptophasa albacosta Lewin	NR
Psychidae	
Lepidoscia arctiella Walker	NR
Lasiocampidae	
Pinara sp.	4
Noctuidae	
Praxis porphyretica Guenee	NR
Cossidae	
Endoxyla lituratus (Donovan)	1, 3, 4
Cosmopterigidae	
Macrobathra chrysotoxa Meyrick	NR
Lycaenidae	
Pseudalmenus chlorinda (Blanchard)	4, 7
Pseudalmenus chlorinda zephyrus Waterhouse & Lyell	6, 7
Tortricidae	
Epiphyas ashworthana (Newman)	4
Epiphyas xylodes (Meyrick)	4

Table 1. (continued)

THYSANOPTERA	
Phlaeothripidae	
Kladothrips sp.	4
B. Species which are inquilines or parasites in galls of *Acacia dealbata.*	
LEPIDOPTERA	
Gracillariidae	
Acrocercops eumetalla Meyrick	NR
Tineidae	
Comodica mystacinella Walker	NR
Pyralidae	
Gauna aegusalis Walker	NR
Tortricidae	
Holocola triangulana Meyrick	NR
Oecophoridae	
Stathmopoda cephalaea Meyrick	NR
HYMENOPTERA	
Pteromalidae	
Coelocyba sp.	NR
Ormyromorpha sp.	NR
Eulopidae	
Chrysoatomus sp.	NR
Tetrastichus sp.	NR
Torymidae	
Megastigmus sp.	NR
Bethylidae	
Sierola sp.	NR
Ichneumonidae	
Delopia sp.	NR

* 1 = Evans (1943); 2 = Elliott (1978); 3 = Elliott and de Little (1985); 4 = Bashford (1990); 5 = Bashford (1991); 6 = Bashford (1993); 7 = Couchman and Couchman (1977); NR = New record for Tasmania.

Discussion

Many of the species listed have been previously recorded on the mainland on a range of wattle species by van den Berg (1982), New (1979), Webb (1994) and Hunt *et al.* (1996). All of the Lepidoptera listed from *Uromycladium* galls have been reared by New (1982) in the Melbourne area from galls on *A. decurrens.* Trees infested by these fungal galls are often severely debilitated.

There is an increased interest in the establishment of *A. dealbata* plantations in Tasmania, on the mainland and overseas for the production of a wide range of timber products. Knowledge of the insect species which are or have potential to become pest species in a plantation situation is important and would be of value to tree growers both overseas and in Australia for possible integrated pest management (IPM) development. Several of the species recorded from Tasmania are recognised as impediments to plantation establishment; for example *Pyrgoides orphana*, a chrysomelid beetle which causes reduced growth increment and, with repeated defoliation, death of trees.

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CD-ROM REVIEW

Victorian Butterfly Database. Viridans Databases (614 Hawthorn Road, Brighton East, Victoria 3187). 1997. Price $120.

This innovative CD-Rom contains information on the 129 butterfly species recorded from Victoria and is a remarkable record of the achievements of two dedicated butterfly enthusiasts, David Crosby and Nigel Quick, over a lifetime of interest in these insects. Some 80% of records result directly from their work, with others incorporated from the Museum of Victoria and other sources. The production has been overseen by Dr Paul Gullan and follows a Victorian Flora database in similar format.

The disc is much more than a superbly illustrated directory to the State's butterflies and will have wide interest as a fundamental information source throughout Australia. Introductory text outlines the biology of butterflies and provides clear explanation of the disc's capacity and uses. The 600 or so photographs (set specimens of all species, many of living butterflies [65 species] and early stages) are augmented by brief description of life cycles, food plants and ecology of each species, plus extensive distributional data which can be plotted and assessed on a range of scales and templates. The database facilitates search for any species, with illustrated lists of scientific or common names as a basis for this; each is also given a conservation status ranking (rare, endangered, vulnerable) where appropriate, plus indication of resident, alien, migrant or vagrant status in Victoria. Its distribution can be shown (using a 10 x 10 minute grid unit) on a map of Victoria and the records can be segregated into 9 temporal categories, to indicate the historical record of documentation and changing distributions during this century. Distribution can also be shown in relation to roads and towns, topography or landsat imagery to indicate land use and major habitat patterns; any main area can be enlarged four-fold by 'zooming' for greater resolution. An area can also be searched for all butterfly records, to produce local listings and any part of the imagery or text can be printed out. It will thus have considerable value to land managers seeking information on particular areas and to students and naturalists of many persuasions. The producers note that this is a 'first edition' subject to augmentation and revision in the future.

I found no major operating problems in using the database and much to commend in its effective operation and retrieval. One can always quibble: perhaps additional photographs of some variable taxa would be useful; perhaps more information as captions on pictures of early stages would help some users seeking to identify these; perhaps some conservation status assessments could be re-interpreted and so on. Such comments are however trivial in relation to the excellence of the overall achievement that this CD-Rom represents. It will have lasting value as an important step in disseminating information on Victoria's fauna - and, tacitly, issues the challenge for emulation for butterflies and other 'flagship' insect groups elsewhere in Australia.

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ALEXFLOYDIA REPENS SIMON: A FOOD PLANT FOR *OCYBADISTES KNIGHTORUM* LAMBKIN & DONALDSON (LEPIDOPTERA: HESPERIIDAE) AND THEIR CONSERVATION SIGNIFICANCE

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Abstract

A food plant for the larvae of *Ocybadistes knightorum* is identified as the rare and locally restricted grass, *Alexfloydia repens* Simon (Poaceae). Adult females of *O. knightorum* were observed ovipositing on this grass at three localities previously recorded for this grass east of Bonville and near Boambee, New South Wales. The conservation significance of *O. knightorum* and its food plant, *A. repens*, is discussed.

Introduction

The recent discovery of *Ocybadistes knightorum* Lambkin & Donaldson near Boambee, northeastern New South Wales, has stimulated interest among butterfly conservationists due to its remarkably restricted distribution. *O. knightorum* has previously been recorded only from the type locality, Boambee Creek (Lambkin and Donaldson 1994, Atkins 1996), where the immature stages were found and adults were observed to oviposit on a grass, thought to be *Hemarthria uncinata* R. Br. (Atkins 1996). However, the distribution of *O. knightorum* is not easily explained by the distribution of this plant since *H. uncinata* is known to be widely distributed from southern and Western Australia (Baines 1981) to eastern Queensland, including the Darling Downs (Stanley and Ross 1989). Atkins (1996) suggested that *H. uncinata* was either the sole or principal food plant for this butterfly but indicated that its identity required confirmation.

A larval food plant for *O. knightorum*

In March and April 1996 at Boambee Creek, central New South Wales, several female *O. knightorum* were observed ovipositing on *Alexfloydia repens* Simon (Poaceae). In February 1997, at two other localities (Pine Creek, east of Bonville; Cordwells Creek, Boambee) where the grass was recorded by Simon (1992), several female *O. knightorum* were observed also ovipositing on *A. repens.* Larvae were found in shelters (as described by Atkins 1996) which were similar in appearance to the glumes of *A. repens* (c.f. Simon 1992). Scars from feeding by larvae on the leaves sometimes resulted in distorted spikelets and these may have been the same as those attributed to insect damage by Simon (1992).

At all localities visited between eastern Bonville and Boambee where *A. repens* was present, *O. knightorum* was also present. The butterfly was absent from similar environments where this grass was absent. *A. repens* occurs as almost monospecific stands on peat-like soils, though the peat areas are often edged nearby with alluvial or saline sandy loams supporting other grasses (e.g *Ottochloa gracillima* C.E. Hubbard).

Ecology and conservation of *O. knightorum* and its food plant

It is likely that the food plant of *O. knightorum* was misidentified in Atkins (1996) as *H. uncinata,* since the present surveys indicate that *O. knightorum* is almost certainly monophagous and dependent on the geographically restricted grass, *A. repens,* as a food plant for its larvae. Simon (1992) referred to the important conservation status of this grass and its extremely restricted distribution. To this must now be added concern for the conservation of the butterfly which appears confined to the grass and therefore at risk. Moreover, the grass may prove to be dependent on small patches of coastal peat, similar to those reported by Hegerl (1996) in the region between Fraser Island and Cooloola National Park in southeastern Queensland. The association of these peat fens with mangroves and tidal wetlands was recognised by Hegerl (1996) as having unique conservation value for flora and fauna and may now include the distinctive butterfly, *O. knightorum* in even more restricted areas. Indeed, if *O. knightorum* and the grass, *A. repens,* prove to be inter-dependent on peat substrates of similar age to those described by Hegerl (1996), the age of the fens may be well in excess of his estimate of 6,000 years.

O. knightorum and *A. repens* have been recorded so far only from four localities between Pine Creek, East Bonville and Boambee Creek, Boambee, central NSW (Simon 1992), a distance of *ca* 8 km, where at least two of the known localities for *O. knightorum* are under threat from commercial development, physical disturbance or weed invasion. One site supporting the butterfly occupies an area of only about 600 m^2. It is hoped that further surveys for *A. repens* will reveal additional localities for *O. knightorum* and that the unique ecosystems supporting these biota will be permanently preserved by appropriate state conservation authorities.

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NEW RECORDS OF THE GENUS *STENUS* LATREILLE (COLEOPTERA: STAPHYLINIDAE) IN AUSTRALIA

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Abstract

Recent Australian records of the genus *Stenus* Latreille are listed and biological notes given. Three species are newly recorded from the Australian Capital Territory, two from Western Australia and one from the Northern Territory.

Introduction

The almost cosmopolitan genus *Stenus* Latreille is one of the largest in the animal kingdom, with about 2000 species. The adults are diurnal predators on soil and leaf surfaces, usually near water, and the larvae are active predators on soil surfaces. The adults, with large bulging eyes, a protrusible labium (Weinreich 1968; Fig. 1) and the peculiar stiff-legged gait of creatures that hunt by stealth, are easily distinguished in the field and make a popular subject for collectors in the northern hemisphere. In the north, small regions such as the British Isles have large, diverse faunas (74 species) and the small scale distribution patterns of species may be correlated with changes in soil type and management systems of grasslands and riverbanks (Allen 1981; Reid 1985, unpubl.).

The Australian fauna has been revised relatively recently (Puthz 1970, 1972, 1975, 1977) and comprises only 29 species. A considerable amount of new material has accumulated in the Australian National Insect Collection, Canberra (ANIC) since Puthz last worked on the Australian fauna. This paper is a record of this new material, and small collections in the Queensland Museum (QM), University of Queensland Insect Collection (UQIC), Queensland Department of Primary Industries, Mareeba (QDPIM) and Zoology Department, James Cook University, Townsville (JCU).

The species are listed in alphabetical order, ignoring subgenera, with notice of new material and notes on distribution and habitat where appropriate. An asterisk (*) indicates new state records. All material is in the ANIC unless otherwise indicated.

Records

Stenus atrovirens Fauvel

*NORTHERN TERRITORY: 3/ Jim Jim Creek, 12°57'S 132°33'E, 19 km WSW Mount Cahill, 24.x.1972 E.B. Britton. QUEENSLAND: 2/ Barron River, Walkamin, 4.vi.1964, RE (QDPIM).

This appears to be a rare species, previously known only from tropical Queensland (Puthz 1970, 1972: 8 specimens).

Stenus australicus Blackburn

No additional material.

This species is still known only from the female holotype, collected at Wandiligong (Puthz 1970), a lowland valley in the Victorian Alps.

Stenus bifenestratus Benick

WESTERN AUSTRALIA: 2/ Forest Dept, 18-22.x.1971, J.A. Springett; 3/ Marri Road, Forest Dept, 8-21.vii.1970, J.A. Springett; 1/ 7 km SE Dwellingup, 32°46'S 116°04'E, 2.x.1981, I.D. Naumann, J.C. Cardale.

This is a frequently recorded species in the more humid forests of south-western Western Australia (Puthz 1970).

Stenus bisignatus Puthz

WESTERN AUSTRALIA: 1/ Pemberton, 3.xii.1936, K.R. Norris.

Previously known from the female holotype, which was also collected at Pemberton (Puthz 1977).

Stenus caviceps Fauvel

No additional material.

This is a widespread species on Cape York Peninsula, north of Cairns (Puthz 1970, 1972).

Stenus coeruleus Waterhouse

NEW SOUTH WALES: 1/ Allyn River Road, 7.6 km from Singleton, 28.vi.1976, W. Allen; 5/ Barrengarry Mountain, 34°40'S 150°30'E, on bushes over ditch, 12.viii.1989, C. Reid; 3/ Barrington House, 92 km NW Singleton, 32°09'S 151°32'E, 28.vi.1976, W. Allen; 4/ Barrington Tops NP, Gloucester River, 32°04'S 151°41'E, 12-14.xi.1981, A. Calder; 1/ 16.5 km S Bermagui, Brochelos Creek, 22.vii.1973, Z. Liepa; 1/ 38.5 km WSW Corumba, 30°14'S 152°43'E, 26.vi.1976, W. Allen; 5/ 3 km N Lansdowne, via Taree, wet scler[ophyll] forest, 20.ix.1983, 24.xi.1984, 21.vi.1985, G. & B. Williams; 3/ Lismore, iii.1922; 1/ Richmond River, 1909-174; 1/ Wallaga Lake, Bermagui, 21.vii.1973, Z. Liepa. QUEENSLAND: 3/ Baldwin Swamp Fauna reserve, 10.x.1972, H. Frauca; 2/ Lake Eacham, 19.viii.1934; 1/ [Lamington] National Park, MacPherson Range, i.1928, H.J. Carter; 1/ c12 km E Ravenshoe, 27.viii.1968, R.J. Elder; 3/ Tinaroo, on wild tobacco, 21.xii.1968, P.H. Twine (QDPIM); 1/ Woombye, nr Nambour, 16.x.1965, D.H. Colless.

This is a common species in rainforest from Clyde River, New South Wales, northwards. It is an active climber on trees and shrubs.

Stenus convexiusculus Benick

No additional material.

This species is known only from high rainfall areas of northern New South Wales and southern Queensland (Puthz 1970, 1972: 10 specimens).

Stenus cupreipennis Macleay

No additional material.

Apparently a common riparian species, which is recorded from Adelaide and Melbourne to Cape York (Puthz 1970, 1972).

Stenus cursorius cursorius Benick

NORTHERN TERRITORY: 3/ Adelaide River, Daly River Rd Xing, 13°29'S 131°06'E, 9.xi.1972, E.B. Britton; 1/ Burrell's Creek, Stuart Highway, 24.xi.1972, D.H. Colless; 3/ Cooper Creek, 19 km SE Mount Borradaile, 12°06'S 133°04'E, stagnant pool in sandy creek bed, 3.xi.1972, E.B. Britton; 11/ Fergusson River, 19°14'S 131°50'E, 7.viii.1968, 13.viii.1968, M. Mendum; 2/ Wilderness River Lagoon, 12°58'S 132°00'E, 24.x.1972, E.B. Britton. QUEENSLAND: 5/ Bakers Blue Mtn, 17 km W Mt Molloy, rainforest, 1100m, 12.ix.1981, G. Monteith & D. Cook (QM); 1/ Bellenden Ker Range, 17°16'S 145°51'E, summit TV stn, rainforest litter, 1500m, 25-31.x.1981, Earthwatch & QM (QM); 2/ Bellenden Ker, 17°16'S 145°51'E, centre peak summit, moss on trees, 10-11.iv.1979, G.B. Monteith (QM); 1/ Cairns, freshwater flood debris, 18.iii.1965, J.G. Brooks; 8/ Davies Creek, x.1950, GB; 2/ Davies Creek, 22 km WSW Mareeba, malaise trap, 2.xii-7.i.1985, Storey, Titmarsh (QDPIM); 1/ Eungella, near school, 9.v.1980, I.D. Naumann, J.C. Cardale; 1/ Lambs Head, 10 km W Edmonton, 1200m, 10.xii.1989, Monteith, Thompson, Janetzki (QM); 10/ Millstream Falls, Ravenshoe, sand by river, ix.1991, C. Reid; 1/ 12 km WNW Mossman, head of Francis Creek, 1200m, 30.xii.1989, ANZSES (QM); 1/ Mount Halifax, 19°07'S 145°23'E, summit heath, 21.iii-10.v.1991, D. Cook (QM); 1/ Mount Lewis, 1060m, 20.vi.1971, Taylor, Feehan; 1/ Mount Lewis barracks, via Julatten, rainforest litter, 1000m, 10.ix.1981, G. Monteith & D. Cook (QM); 1/ Mount Misery, 15°52'S 145°14'E, summit, flight intercept, 850m, 17.i.1991, QM & ANZSES (QM); 1/ Mount Williams, 16°55'S 145°40'E, 1000m, 2.xii.1993, Monteith & Janetzki (QM); 1/ Murray Falls, N of Cardwell, on rocks by river, viii.1996, C. Reid; 3/ Silver Valley, ix.1950, GB; 1/ Taringa, 7.i.1931; 6/ Townsville, F.H. Taylor; 2/ Windsor Tableland, flt intercept, 27.xii-10.i.1989, E. Schmidt & ANZSES (QM). *WESTERN AUSTRALIA: 2/ Mining Camp, Mitchell Plateau, 14°49'S 125°50'E, 9-19.v.1983, I.D. Naumann, J.C. Cardale.

This is a widespread and abundant riparian and rainforest species in the northern tropics as far south as Rockhampton (Puthz 1970), newly recorded here from Western Australia.

Stenus gayndahensis Macleay

*AUSTRALIAN CAPITAL TERRITORY: 2/ Canberra, marshy pond by ANU campus & Clunies Ross St, 19.ix.1985, C. Reid. NEW SOUTH WALES: 1/ 18 km SW Braidwood, marshy stream, 30.i.1986, C. Reid; 2/ Darling River, v.1925, H.J. C[arter] (1 Puthz coll.); 1/ Wambelong Creek, Warrumbungle NP, 31°19S 148°59'E, 8.i.1977, S. Allen. QUEENSLAND: 3/ Archer Creek, x.1953, GB; 2/ Broken River, 50 mi W Mackay, 30.xi.1968, E. B. Britton (1 Puthz coll.); 4/ Dargonelly Rockhole, 25°02'S 147°54'E, 27.ii.1996, G. Monteith & C. Burwell (QM); 1/ Blackdown Tableland via Dingo, 850-950m, 11-12.iv.1996, G. Monteith (QM).

This plant climbing species in marshy habitat (with many emergent plants), is widely distributed from southern New South Wales to north Queensland.

Stenus guttulifer Waterhouse

No additional material.

This species is widespread in the more humid regions of southwestern Western Australia (Puthz 1970, 1972). Nineteenth century records from Queensland and New South Wales are probably erroneous.

Stenus hornensis Puthz

No additional material.

Still known only from the female holotype, Horn Island, Northern Territory (Puthz 1970).

Stenus immaculatus Puthz

WESTERN AUSTRALIA: 3/ Pemberton, Brockman NP, karri forest, 26.x.1969, R.W. Taylor; 3/ Pemberton, 23.ix.1971, J.A. Springett; 1/ 12 mi N Walpole, c250m, marri forest, 24.x.1969, R.W. Taylor.

This species is confined to the small high rainfall area of southwestern Western Australia. It was previously known only from the female holotype, collected in Walpole-Nornalup NP.

Stenus improbus Puthz

QUEENSLAND: 1/ Bellenden Ker Range, cableway base stn, pyrethrum knockdown, 100m, 17.x-9.xi.1981, Earthwatch & QM (QM); 1/ Cairns, freshwater flood debris, 18.iii.1965, J.G. Brooks.

This rare species was previously known from the holotype (Cairns) and four northern Queensland specimens in the Blackburn collection (Puthz 1970, 1972). It is possibly confined to lowland rainforest.

Stenus janthinipennis Lea

No additional material.

A riparian species, which is common in the Kimberleys and near Darwin (Puthz 1970, 1972).

Stenus leai Bernhauer & Schubert

No additional material.

Apparently a rare species, which is known from the Kimberleys and northern Queensland (Puthz 1970).

Stenus macellus Fauvel

No additional material.

The species is still known only from 6 nineteenth century specimens collected at Albany, in SW Australia (Puthz 1970).

Stenus maculatus Macleay

NEW SOUTH WALES: 2/ Broulee, 35°51'S 150°11'E, 26.v.1982, T. Watson, L. Miller; 1/ Mebbin SF, 18 km W Uki, 23-24.xi.1982, J. Doyen; 1/ Victoria Park via Alstonville, 1.xi.1970, G.B. Monteith (UQIC). QUEENSLAND: 1/ Brookfield, 10.ix.1933, J.G. Brooks; 1/ Conway State Forest, Brandy Creek Rd, 23.iv.1979, G.B. Monteith (QM); 1/ Granite Creek, Bulburin State Forest via Many Peaks, 1.iv.1972, G.B. Monteith (UQIC); 2/ Greater Brisbane, Wassel; 1/ Joalah NP, Tambourine Mountain, 27°56'S 153°12'E, on flowers & foliage, 18-21.x.1978, Lawrence & Weir; 1/ Mount Nebo, 10.xii.1933, J.G. Brooks; 1/ c3 km W Paluma, c888m, ex leaf litter, 11.i.1975, J.G. Brooks; 1/ Mount Irvine; 1/ Redland Bay, ix.1950, GB; 1/ Seaview Range, Mt Fox Rd, rainforest, 600m, 2.i.1987, S. Hamlet (QM).

The localities listed above and those given by Puthz (1970, 1972) suggest that this is a subtropical and tropical rainforest species, not a species "of open forest" (Puthz 1970: 75), occurring from Clyde River, New South Wales, northwards. It is not present in the cooler rainforest preferred by the similar *S. pustulifer* Fauvel. The species climbs low vegetation.

Stenus neboissi Puthz

No additional material.

This species is known only from the 4 type specimens, collected in Cairns and Halifax, North Queensland (Puthz 1970).

Stenus olivaceus Macleay

No additional material.

A widely distributed riparian species, recorded from southern New South Wales to Cairns (Puthz 1970, 1972).

Stenus piliferus obesulus Fauvel

NEW SOUTH WALES: 1/ 1 km S Harrington, swept Casuarina & Acacia complex, 21.ix.1983, G. Williams. NORTHERN TERRITORY: 1/ 3 km SSW Katherine, 14°30'S 132°15'E, 12.xi.1979, T. Weir; 19/ Muirella Park, 12.x.1972, E.F. Riek. QUEENSLAND: 4/ Arriga, Mareeba, ex rice paddy, 16.iv.1985, K.H. Halfpapp (QDPIM); 13/ Didgeridoo Waterhole, Baratta Creek, viii.1991, Burdekin River Project (JCU); 4/ Innisfail, 5.ix.1965, R. Angus (1 Puthz coll.); 1/ 2 mi SW Mount Inkerman, 19°45'S 147°30'E, mud, lily ponds, 11.xii.1968, Britton & Misko. VICTORIA: 1/ East Pombornheit, 24 km ESE Camperdown, temporary pond, viii.1978-ii.1979, P.S. Lake. *WESTERN AUSTRALIA: 1/ 14 km SE Kalumburu Mission, CALM site 4/3, 12°45'S 126°40'E, 3-6.vi.1988, T.A. Weir.

A common riparian vegetation climber, from southern South Australia to the eastern and northern seaboards of Australia (Puthz 1970, 1972), not previously recorded from Western Australia.

Stenus platythrix Puthz

QUEENSLAND: 1/ 2 km S Beatrice River, 17°34'S 145°41'E, rainforest pitfalls, 1.xii-25.ii.1994, J. Hasenpusch (QM); 1/ 4 km up Black Mountain Road, Kuranda, malaise trap, 25.viii.-14.ix.1982, G. Simpson; 1/ Mount Lewis via Julatten, 3500', 4.v.1970, G.B. Monteith (UQIC); 2/ same locality, rainforest, 12.x.1980 (QM).

This is a fairly common species, confined to the region around Cairns and the Atherton Tableland, North Queensland (Puthz 1970, 1972).

Stenus praedictus Puthz

QUEENSLAND: 1/ Bellenden Ker Range, Cable Tower 3, beating rainforest, 1054m, 17.x-5.xi.1981, Earthwatch & QM; 1/ Crater, vii.1969, GB; 1/ Crater National Park, Atherton Tableland, 950m, pyrethrum, 28.xii.1990, G.B. Monteith (QM); 1/ Kirrima Range via Kennedy, rainforest, 500m, 2.x.1980, G.B. Monteith (QM); 2/ Malanda Falls, Malanda, rainforest, 750m, 8-12.x.1980, G.B. Monteith (QM); 2/ Mount Lewis, ix.1969, GB; 1/ Mount Lewis via Julatten, 3500', 4.v.1970, G.B. Monteith (UQIC).

The above records indicate that this species is widely distributed, in high rainfall and relatively high altitude areas of North Queensland, from Kirrima Range to Mount Lewis (Puthz 1975, 1977).

Stenus pseudocoeruleus Puthz (Fig.1)

QUEENSLAND: 2/ Cairns, 18.xi.1934, J.G. Brooks; 1/ Mount Webb NP, 15°04'S 145°07'E, 28-30.ix.1980, T. Weir; 13/ Russel River, Bellenden Ker landing, 5m, beating rainforest, 24.x-9.xi.1981, Earthwatch & QM; 2/ Bellenden Ker Range, cableway base stn, beating rainforest, 100m, 17.x-9.xi.1981, Earthwatch & QM (QM); 1/ same locality, 8.iv.1987, E.C. Dahms & G. Sarnes (QM); 1/ Smithfield, 16°49'S 145°41'E, beating rf trees, 22.v.1997, C. Reid (ANIC); 3/

South Johnstone Research Station, on banana frond, 15.viii.1990, K.H. Halfpapp (QDPIM); 1/ South Johnston, off banana plant, 19.vi.1970, B. Franzmann (QDPIM); 1/ Tully, on leaf *Musa cavendishii*, 19.viii.1970, B. Franzmann (QDPIM); 1/ Yarrabah, 17.v.1976, E.B. Britton.

This active plant climber is a common species of high rainfall areas in North Queensland, with an isolated record from northern New South Wales (Puthz 1970: Eungai).

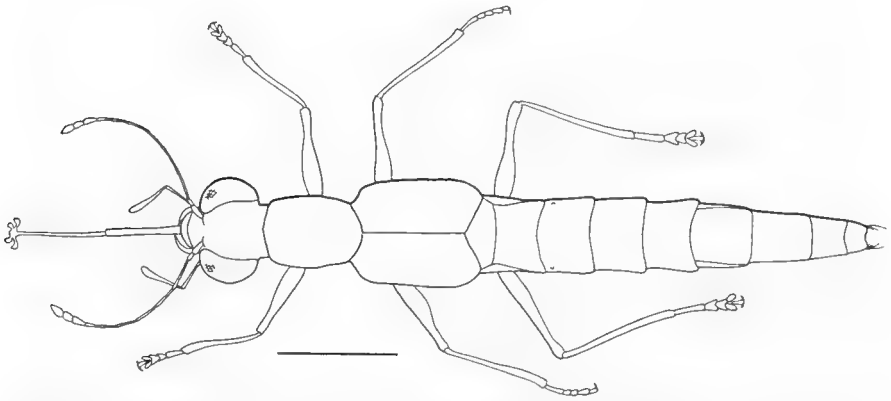

Fig. 1. *Stenus pseudocoeruleus* Puthz, male, with labium extended. Scale bar = 1 mm.

Stenus puncticollis Fauvel

*AUSTRALIAN CAPITAL TERRITORY: 1/ Canberra, Sullivan's Creek, mud & reeds, 18.ii.1985, C. Reid; 1/ Uriarra Crossing, 30.xii.1985, K.R. Pullen. VICTORIA: 3/ Churchill NP, under bark, 12.vi.1973, P.J. Parsons.

A common riparian species, which occurs from Victoria to Brisbane, with old material from Cairns (Puthz 1970). It is evidently capable of overwintering under bark.

Stenus pustulifer Fauvel

*AUSTRALIAN CAPITAL TERRITORY: 2/ Brindabella Range, Blundells Creek-Lees Creek area, 35°22'S 148°50'E, 1979-1981, C.R. Dickman; 1/ Tidbinbilla Reserve, 21.iii.1971, K.R. Pullen; 1/ Tidbinbilla NR, 2 km S Tidbinbilla Mountain, leaf litter, rainforest gully, 24.xi.1990, C. Reid. NEW SOUTH WALES: 1/ 22 km N Armidale, 30°31'S 151°32'E, 4.x.1971, S. Misko; 3/ Barrengarry Mountain, 34°41'S 150°31'E, 24.vi.1971, S. Misko; 1/ Barrington House via Dungog, 14.viii.1970, G.B. Monteith (UQIC); 1/ Beaumont, W side of valley, 20.ii.1974, S. Misko; 1/ Brown Mountain, rainforest at summit lookout, 5.xi.1987, C. Reid; 1/ Clyde Mountain, 750m, 26.x.1982, J. Doyen, J. F. Lawrence; 1/ Gloucester River, Barrington Tops NP, 32°04'S 151°41'E, 12-14.xi.1981, T. Weir; 3/ Macquarie Pass, 7 km ENE Robertson, 34°34'S 150°40'E, 8.ii.1984, I.D. Naumann; 1/ Monga SF, 35°35'S 149°55'E, 26.xi.1979, Lawrence & Weir; 1/ Mount Flora, nr Mittagong, 34°22'S 150°26'E, 15.iv.1976, R.W. Taylor; 1/ Mount Keira, 4.xi.1956, E.F. Riek; 2/ 2 km W Mount Keira, rainforest shrub, 30.iii.1990, C. Reid; 1/ New England NP, Point Lookout, 5,200', 10.xi.1968, C.W. Frazier; 1/ Mount Tomah, Blue Mountains, 4.xii.1971, G.B. Monteith (UQIC); 1/ Upper Allyn River, 14.ii.1968, D.H. Colless; 1/ Wadbilliga NP, 22 km NE Nimmitabel, grass under *Leptospermum*, vi.1988, C. Reid. QUEENSLAND: 1/ Brisbane, 20.v.1964, H.A. Rose (UQIC); 1/ Mount Bithongabel,

Lamington NP, 4.xi.1989. G. Monteith (QM); 1/ Spicer's Peak summit, 28°06'S 152°24'E, 1200m, 30-31.xii.1993, G.B. Monteith (QM); 1/ nr The Crater, 18 km N Ravenshoe, 17°27'S 145°29'E, 28-29.xi.1981, J. Balderson.

This is a common species of cool temperate to subtropical rainforest and wet sclerophyll forest, from Victoria to south Queensland, with isolated occurences further north at Eungella and Ravenshoe. The species generally occurs in cooler forest at higher altitude than the morphologically similar *S. maculatus* Macleay. It climbs low vegetation and overwinters in grass-tufts and moss.

The female specimen from Mount Bithongabel (Qld) has proportionally shorter elytra, narrowed at base, covering short wings (1.5 times elytral length), and has first four tergites more sparsely punctured (almost impunctate), compared with the other material. It may represent a new species or a brachypterous morph of *S. pustulifer*.

Stenus retitogatus Puthz

NORTHERN TERRITORY: 2/ Delamere, 20-25.v.1968, M. Mendum. QUEENSLAND: 2/ McLeod River, 6.viii.1969, J.G. Brooks.

This is a rarely collected riparian species of the drier parts of tropical Queensland and the Northern Territory, previously known from the 3 type specimens (Puthz 1970).

Stenus villosiventris Lea

NEW SOUTH WALES: 1/ Pearl Beach, muddy creek in rainforest, xi.1984, C. Reid.

This is a fairly common species in Victoria and the Sydney region (Puthz 1970, 1972), which has also been recorded from Cairns and Western Australia (Puthz 1970), both probably erroneous localities.

Discussion

In Britain I was a keen collector of this genus and had collected more than 60 species, so when I came to Australia in 1984 I was sure that I would find many new species. My research here on Chrysomelidae has not allowed a serious investigation of suitable habitats for *Stenus*, but I have looked for *Stenus* species whenever possible. In 12 years only 6 species have been collected, none new to science. Areas of bare riparian mud which would support many species in the northern hemisphere, have been examined in many inland regions of Australia and in the Perth area, without success. Grasslands in the Canberra area have failed to produce any species and I have found nothing in the alpine regions of southern Australia, except *S. pustulifer* which is not recorded above 1200m. Tasmania has also been searched unsuccessfully for *Stenus* species and, like New Zealand, this island remains *Stenus*-less. In contrast, in nearby Java, *Stenus* species are diverse and abundant in submontane forests (pers. obs.).

In Australia, *Stenus* species are relatively rare and ecologically insignificant. The highest diversity of species is in the wet tropics of north Queensland. At least 16 of the 29 Australian species occur there, a few of which are common

diurnal predators on the leaves of rainforest bushes, with others common on bare ground by water.

Acknowledgments

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ARCUCORNUS, A NEW GENUS IN THE PSILOMORPHINI (COLEOPTERA: CERAMBYCIDAE: CERAMBYCINAE) WITH TWO NEW SPECIES

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Abstract

Arcucornus gen. nov. is erected in the cerambycid tribe Psilomorphini for *A. occidentalis* sp. nov. and *A. orientalis* sp. nov., described from unique specimens from southern Western Australia and far northern Queensland respectively.

Introduction

Representatives of the endemic Australian tribe Psilomorphini are rare. In a revision of the genus *Psilomorpha* Saunders, Scambler (1989) noted that of the 7 species described, only 217 specimens had been located, these having been collected over a period of 150 years. Similarly, with *Ischnauchen* Scambler, a genus assigned to Psilomorphini by Scambler (1993), only 14 specimens were recorded. Another new genus, *Arcucornus*, with two new species is now proposed. Each species is known by a unique specimen.

Arcucornus gen. nov.

(Figs 1-2)

Type species *Arcucornus occidentalis* sp. nov.

Diagnosis. Body length 25-30 mm, slender, elongate. Head large, nitid, with obtusely triangular profile in sagittal plane and with short to medium length, parallel-sided, moderately deflexed muzzle. Mandibles large, curved, sharp, margins and apices black. Maxillary and labial palpi prominent, subequal in length, setose. Eyes very prominent, large, slightly to fully pyriform, coarsely granulate. Antennae slender, equal to body length, inserted on well-separated, prominent tubercles, scape apically incrassate, approximately equal in length to next three segments together, basal segments with a line of, or fully clothed with long, very fine, erect setae. Defensive secretory 'pit and tongue' mandibular organs absent. Prothorax with two pairs of dorsal tubercles of varying prominence and laterally with single, very prominent, markedly dorsally arcuate, aculeate tubercles. Scutellum medium-large, amber, depressed, apically rounded. Elytra *ca* 0.7 body length, gradually tapered, yellow to buff, shoulders brown. Disc flat, with three or four slightly raised costae and suture. Inter-costal areas mostly amber, with one or two areas darker and with dense, recumbent, very short, very fine vestiture. Legs long, slender.

Etymology. Derived from the Latin *arcus*: curve, bow; *cornus*; horn.

Discussion. Characters of *Arcucornus* which place it in the tribe Psilomorphini are: yellowish-brown coloration, sometimes with distinctive markings; elongate, gracile form; prominent muzzle and eyes; tapering, costate elytra and long, slender legs. The absence of defensive, secretory 'pit and tongue' organs on the head described by Moore and Brown (1971) distinguishes *Arcucornus* and other psilomorphines from the genera *Stenoderus* Dejean (= *Stenocentrus* McKeown) and *Syllitus* Pascoe in the closely related tribe Stenoderini. The primary characters separating *Arcucornus* from other genera of the Psilomorphini so far described, are its size, which is twice the length of the largest specimen from any other genus, the unique structure of its lateral prothoracic tubercles and its intercostal coloration.

The type species was bred from Western Australian Karri, *Eucalyptus diversicolor* F. Muell. by R.P. McMillan of Denmark, W.A., who states that no other specimens were bred or collected (pers. comm.). Nothing is known of the biology of the second species from far north Queensland.

Key to males of species of *Arcucornus*

Elytra each with 4 costae; head with long, erect, fine setae ventrally, on frons, mandibles; antennal scape apically darker than base; basal antennal segments setaceous radially; area between costae 3 and 4 darker than background, less so apically; elytral apices rounded ..... *occidentalis* sp. nov.

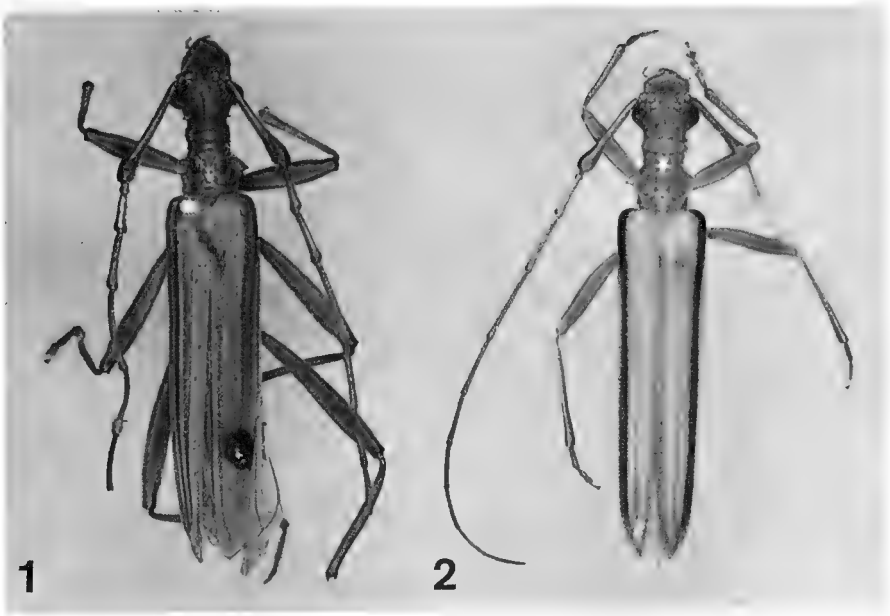
Elytra each with 3 costae; head glabrous except for recumbent setae on labrum; antennal scape unicolorous; basal antennal segments with a line of setae on one side; area between costae 2 and 3 dark brown basally, becoming lighter apically, elytral apices pointed ..... *orientalis* sp. nov.

Arcucornus occidentalis sp. nov.

(Fig. 1)

Type. Holotype ♂, WESTERN AUSTRALIA: Denmark, as larva in Karri, 20.v.1973, pupa 6.vii.1973, adult 11.ix.1973, R.P. McMillan (in Western Australian Museum Collection, 94/846).

Description. Male. Overall length 30 mm. Head *ca* 1.5 times as long as prothorax, ventrally rugulose, tapering to prothorax immediately behind eyes, with long, erect, fine setae ventrally, on lateral margin of frons, dorsal base of mandibles and immediately posterior to eyes. Labrum with coarser, recumbent setae. Eyes slightly pyriform, well separated from ventral margins of antennal insertions, with fine, long, erect setae immediately postero-laterally. Antennae amber, scape apically darker, longer than next three segments together. Scape, pedicel and segment 3 somewhat sparsely setaceous radially, segments 4-6 setaceous on one side, remainder pruinose.



Figs 1-2. (1) *Arcucornus occidentalis*, holotype male (dark object on right elytron is immovable foreign body); (2) *Arcucornus orientalis*, holotype male. Scale line = 5 mm.

Segments 3-6 progressively longer, 7-8 progressively shorter (remainder missing). Prothorax amber, ventrally rugulose, anterior/posterior width ratio *ca* 0.8, with sparse, fine, erect setae antero-laterally, antero-dorsal tubercles prominent, postero-dorsal tubercles less so. Elytra with four costae, 1 and 2 clearly defined, integral with similarly formed carina at base of elytra. Costa 3 weaker, arising sub-humerally, costa 4 similar, arising posterior to 3 and becoming more strongly defined apically. All costae parallel, all joining preapically. Area between costae 2 and 4 darker than background, becoming less so apically. Elytral apices faintly rounded, margined with very short setae. Legs amber, forelegs with sparse, fine, erect setae, middle and rear tarsi with similar, sparser setae. Fore and mid-coxae globose, contiguous, rear coxae transverse, almost contiguous.

Female unknown.

Etymology. Derived from the Latin *occidentis*: west.

Arcucornus orientalis sp. nov.

(Fig. 2)

Type. Holotype ♂, QUEENSLAND: Kuranda, N.Q., 6.ix.1975, A. & M. Walford-Huggins (in Queensland Museum, QMT. 46010).

Description. Male. Habitus similar to *A. occidentalis*. Overall length 25 mm. Head *ca* 1.2 times as long as prothorax, glabrous except for sparse, recumbent setae on labrum. Muzzle rather short. Eyes pyriform. Antennae unicolorous, scape slightly shorter than next three segments together, basal segments with a line of fine, erect setae on one side. Segments 3-5 progressively longer, 6 and 7 shorter and equal, 8 shorter, 9-11 shorter than 8 and equal. Prothorax with single, fine, erect seta laterally on anterior margin, dorsal tubercles slightly and equally prominent. Elytra with 3 costae, costa 3 very weakly defined, becoming somewhat more defined apically. Area between costae 2 and 3 microtuberculate, dark brown basally, becoming slightly lighter apically. Elytral apices pointed.

Female unknown.

Etymology. Derived from the Latin *orientis*: east.

Acknowledgments

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NOTES ON THE BIOLOGY AND ANNUAL CYCLE OF THE WOOD BORING PSOCOPTERAN *PSILOPSOCUS MIMULUS* SMITHERS (PSOCOPTERA: PSILOPSOCIDAE)

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Abstract

Preliminary information is provided on some aspects of the biology and seasonal cycle of the unusual wood boring psocopteran *Psilopsocus mimulus* Smithers on *Pinus radiata* in New South Wales.

Introduction

Unusual morphological features of the nymphs of the uncommon psocopteran *Psilopsocus mimulus* Smithers led to the suspicion that it might live within the confines of a tunnel of some kind (Smithers 1963). Not until 1993 was it confirmed as a wood borer, after a substantial population was found in Penrose State Forest, near Marulan, NSW (Smithers 1995b).

Information on the biology of Australian Psocoptera is very meagre. This note summarises preliminary observations on some aspects of the biology and seasonal cycle of *Ps. mimulus*.

Materials and methods

Observations were made at Penrose State Forest between December 1993 and May 1995, in a stand of mature *Pinus radiata* D. Don. and on specimens reared in the laboratory. Prior to this the species had been collected only occasionally in small numbers at various localities in eastern Australia (Smithers 1995b). In the laboratory, field-collected insects were kept in petri dishes lined with absorbent paper and provided with pine twigs of various thicknesses, never thicker than a few mm in diameter and about 6 cm long, into which they could bore. Water was provided on a wad of cotton wool which was kept damp but not wet enough to allow water to seep onto the paper.

Notes on the biology of *Psilopsocus mimulus*

Adult *Ps. mimulus* do not exhibit unusual morphological features but the nymphs show remarkable adaptations to life in a tunnel. These include a cylindrical body form, short legs, reduced sclerification and pigmentation of the abdominal integument, except for the hind part of the abdomen which, in contrast, is exceptionally heavily sclerotised and black, with a truncate posterior end and specialised setae, of which the tips are divided into several short, divergent branches (Smithers 1963, 1995a). The cylindrical form and colour of the heavily sclerotised hind end of the abdomen is reminiscent of wood boring beetles which block their tunnels by means of appropriately shaped elytra. *Ps. mimulus* has been recorded only on *Syncarpia glomulifera* (Smith) and *Pinus radiata*.

Adults

Food and feeding. Adults are found on the bark of the trunk, branches and twigs of the trees. They are too large to enter the tunnels in twigs in which the nymphs live. Fungal hyphae (derived from lichens or fungi on the bark surface?), fungal spores, green algae and fragments of plant detritus have been found in the gut.

Initially water was provided as droplets in the petri dishes as well as on the cotton wool pads. They drank from both sources. Rudolph (1982a, b) described and discussed the mechanism of water vapour uptake through the hypopharynx in psocopterans. In controlled experiments he recorded uptake periods of about 5-40 minutes, with varying intervals between them depending on species and conditions. During these periods the lingual sclerites are conspicuously exposed beyond the buccal cavity. Females of *Ps. mimulus* were observed extending and retracting the hypopharynx in the manner described by Rudolph and it is assumed that this was in order to absorb atmospheric moisture. The hypopharynx was exposed for periods varying from 20-60 seconds, alternating with periods of 10-15 seconds of withdrawal. The observations on *Ps. mimulus* were made under uncontrolled conditions and it is mentioned here simply to record its occurrence.

When at rest adults often adopt a posture in which the head is rested against the substratum and the abdomen raised at a wide angle to it, an unusual stance for a psocopteran.

Length of adult life. Adults in the laboratory lived 6-67 days. The longest-lived specimen was a male; the longest-lived female lived 51 days. Most specimens lived fewer than 40 days.

Mating. Mating was not observed but that it can take place soon after maturity is suggested by the fact that one female laid viable eggs only 4 days after the final nymphal moult. Prenuptial behaviour was not observed but probably does take place as this is known in many psocopterans, including the Myopsocidae (Campbell 1928), which are closely related to the Psilopsocidae (Mockford 1961).

Oviposition. Females can lay eggs as soon as 4 days after emergence and continue to do so until they are at least 11 days old. It is very likely that females produce eggs until much older as most of them lived much longer in the laboratory. This conclusion is supported by the fact that females contain only about 6 mature eggs at a time, with many more in earlier stages of development within their ovaries. Eggs are laid singly and it can be assumed that in the field the oviposition period is much longer than 11 days. When a female is about to lay she drags the end of her abdomen over the surface of the bark, sometimes probing into crevices. This may continue for a minute or more. Eventually the posterior margins of the paraprocts and the epiproct are pressed against the bark. After a brief pause an egg is quickly extruded and adheres to the bark. The egg is wet and shiny when deposited but dries

and becomes dull almost immediately. As the abdomen is withdrawn the egg is covered with a wet encrustation of faecal material which also dries almost immediately. As the end of the abdomen is raised the encrustation is moulded into a characteristic shape. The encrustation surrounds the egg and has a flat upper surface. This upper part is drawn out horizontally in one direction into a flattened plate which extends a little beyond the egg and slightly upwards as the female withdraws her abdomen. The edge of this flat extension is irregular, projecting in one or two places along its edge. The encrustation is the same colour as the bark with the result that the egg is difficult to see. Although several females were observed laying, none was seen to deposit a second egg within about half an hour. This seems to be an unusually long interval and it is possible that conditions in the petri dishes were not conducive to normal oviposition procedures and that oviposition is more frequent in the field.

Eggs

Hatching. The egg stage lasts 20-26 days. Eclosion took 24 mins from the first signs of a break in the chorion to freedom from the pronymphal cuticle.

Nymphs

Appearance. The integument of the newly hatched nymph is translucent and large bubbles can be seen moving in the gut. It takes several hours for the nymphs to colour up to the point at which the end of the abdomen is somewhat dark and sclerotised. First instar nymphs do not have the strongly sclerotised, black cylindrical form of the posterior part of the abdomen developed as extensively as in later instars. This and the form of later instars have been discussed by Smithers (1995a).

Tunnel making. First instar nymphs may initially force their way into cracks and crevices, leaving the somewhat sclerotised hind end of the abdomen exposed but soon seek out the end of a broken twig and make their own tunnels or enter and occupy an existing, vacated tunnel. They start to make a tunnel soon after their integument has hardened and attained normal colour. Older nymphs may change tunnels and nymphs of all stages will accept tunnels not of their own making. An advanced nymph made a tunnel in a twig of which the end was cracked, so some of the activity of the nymph was observed through the slit. After chewing the wood at the end of the twig to make a short entrance to the tunnel, the nymph chewed at the wall of the tunnel to widen it. It then continued chewing at the central core to extend the tunnel along the length of the twig. Chewing was almost continuous for more than an hour. There were occasional short pauses during which the only activity consisted of slight, brief contractions of the abdomen or voiding of faecal pellets. The nymph turned from time to time on its long axis, chewing different sides of the tunnel. This resulted in a smooth-sided tubular tunnel being made, a little wider than the head capsule. Tunnelling continued until the nymph was well into the tunnel before there was a longer pause in activity.

The wood removed from the wall of the tunnel is swallowed, passed through the gut and ejected as faecal pellets (Smithers 1995b). These are pale when they result from tunnel extensions, dark, almost black, when the insect is feeding. Nymphs appear always to be alone in the tunnels. On one occasion a second nymph was seen to enter an occupied tunnel. The original occupant backed up along the tunnel, causing the new arrival to retreat out of the tunnel, after which the original occupier remained with the end of its abdomen blocking the tunnel for several minutes before disappearing down the tunnel again.

Feeding and defecation. Nymphs spend most of their lives in their tunnels. They feed on the wood of the central core of the twig. They were occasionally seen on the surface of the twigs where, on one occasion, one was seen to feed on the surface of the bark. Whether *Ps. mimulus* is capable of digesting cellulose of the plant cells or subsists only on fungal growth in the tunnel is not known. The gut contains spores, pieces of fungal hyphae and remains of woody tissues. Nymphs were seen taking water from the cotton wool wad but not taking up water vapour through the hypopharynx as do the adults.

Judging by the cessation of defecation, it would appear that feeding ceases some time before ecdysis, perhaps 48 h or more. Faecal pellets are not produced during this period. Feeding starts soon after moulting. Protozoa which might be involved in aiding digestion were not found in the gut of the few specimens examined.

Remarkably large quantities of faecal material are voided by nymphs, suggesting that they feed on something of limited nutritional value or a food source in limited supply obtained from the wood, such as fungi developing on wood in the tunnel. During periods of feeding and tunnel making, the nymph backs along the tunnel to the entrance, exposes the end of the abdomen and ejects a faecal pellet (Smithers 1995b). This is a surprisingly frequent event. One recently moulted nymph produced its first faecal pellet within 24 h of moulting. In the next 24 h it produced 19 pellets and 130 faecal pellets over the next 6 days. Seven of the pellets were pale. When extending the tunnel the rate of pale faecal pellet production may be greater than usual. In one case it was as high as 3 per hour and in another occurred at intervals of 3-12 mins over a period of more than an hour, during which time 9 pellets were produced.

Moulting. The nymph leaves the tunnel prior to ecdysis, which may take place near the tunnel entrance or some distance away. It is not known how far a nymph will move from its home tunnel in the field or whether it always returns to its home tunnel. Ability to find its own tunnel again may not be important. In the laboratory nymphs did move into tunnels made by others. Full colour of the integument is regained about 2 h after ecdysis. Prior to the final nymphal moult, feeding and faecal pellet production appears to cease for several days. One nymph was seen to re-enter its own tunnel without

difficulty soon after ecdysis, despite the increased size of its head capsule, indicating that provision for the anticipated change in size must have been made by increasing tunnel diameter before the moult took place.

Instars. As the nymphs live in tunnels and survival rate was low in the laboratory, it was difficult to determine accurately the number of nymphal instars by direct observation. Fluctuation in faecal pellet numbers and size in petri dishes containing several nymphs suggest that they undergo the 6 instars usual for Psocoptera. Final instar nymphs first appeared in the field in May and the major emergence of adults was in November. Faecal pellet measurement and counts of pellet production by individuals would enable accurate data on number and length of instars to be obtained. However, improved rearing techniques are required to ensure greater survival rate of nymphs before this can be done.

Annual cycle

Ps. mimulus has one generation a year. Fig. 1 shows the seasonal occurrence of eggs, nymphs and adults. The figure gives the appearance of several weeks delay between emergence of the first adults and commencement of oviposition. This is probably not so. Eggs are very difficult to find in the field as they are well camouflaged and laid singly. Although a few adults (recorded in Fig. 1) may be present in the field from the middle of September, the adult population is clearly at its peak in November and December, suddenly declining in early January. It can be inferred that there are certainly some eggs in the field by the end of September as females emerging later in the laboratory were capable of laying eggs within a few days. In Fig. 1, the first recorded eggs, laid during the week of 18 November, are those associated with a sudden major November emergence of adults. As adults emerge over a fairly long period, are long-lived and clearly lay over a long period, small nymphs occur when nymphs which have hatched earlier in the season are already in a later instar, as is the situation in January.

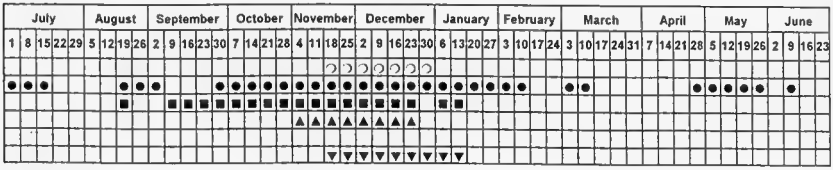

Fig. 1. Seasonal cycle of *Psilopsocus mimulus* on *Pinus radiata*. Laboratory and field records from Penrose State Forest combined on a weekly basis from December 1993 to May 1995. ○ = eggs; ● = nymphs; ■ = adults; ▲ = peak period for adults; ▼ = *Corticaria japonica* beetles.

Natural enemies and associates in the tunnels

One species of chalcidoid parasite, not yet identified, is the only natural enemy so far definitely associated with *Ps. mimulus*. It was found attacking nymphs in the tunnels and itself pupating there in a silken cocoon. Some dead nymphs were found covered in a white fungus but it is not yet known if this is a parasitic fungus or a saprophyte associated with dead nymphs.

A small beetle, *Corticaria japonica* Reitter (Lathridiidae), occurs in empty tunnels of *Ps. mimulus*, sometimes several in one tunnel, from mid November to January. It has not yet been seen in a tunnel with a nymph nor has it been seen attempting to enter an occupied tunnel. *C. japonica* is recorded feeding on fungal spores.

The unusual nymphal habitat of *Ps. mimulus* and its wood boring and feeding habit suggest that detailed study and comparison with the biology of other wood boring insects would be interesting.

Acknowledgments

I would like to thank my wife for considerable assistance in the field and for recording data when I was not able to do so, the Forestry Commission of NSW for permission to work in State Forests, Dr John Lawrence for identifying the beetle, Professor Irma Kalinovic for assistance in the field during her visit to Australia and Dr Jack Simpson for providing information on material in gut contents.

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FIELD OBSERVATIONS ON THE SYMBIOTIC INTERACTIONS OF *OGYRIS GENOVEVA* (HEWITSON) AND *OGYRIS ZOSINE* (HEWITSON) (LEPIDOPTERA: LYCAENIDAE) WITH *CAMPONOTUS* SPP. (HYMENOPTERA: FORMICIDAE)

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Abstract

Observations are presented on the behaviour of *Ogyris genoveva* and *O. zosine* and their attendant *Camponotus* ants.

Introduction

The early stages of *Ogyris genoveva* (Hewitson) and *O. zosine* (Hewitson) have been the subject of a number of biological papers since Miskin (1883) (see Lyell 1905; Waterhouse 1941a, b, Edwards 1948, 1959, McCubbin 1971, Fisher 1978, Common and Waterhouse 1981, Moore 1990, Turner and Hawkeswood 1992). *O. genoveva* occurs throughout most of south-eastern Australia, extending west into South Australia and north into central and northern Queensland, while *O. zosine* occurs over much of northern and eastern Australia, including offshore Barrier Reef and Torres Strait Islands, extending into central and Western Australia (Common and Waterhouse 1981). There are some sympatric populations in south-eastern Queensland and northern New South Wales and both species of *Ogyris* Westwood are almost exclusively attended by ants of the genus *Camponotus* Mayr.

Biological observations have been made by the author over several years and an intensive study was undertaken prior to and during the filming of a documentary on insects, a segment of which was filmed at Eatonsville, west of Grafton, NSW, in November 1993.

Study areas

The principal study site was situated at Eatonsville, extending from approximately 3 km east to 16 km west of the town, where 39 separate colonies of *O. genoveva* were studied in four distinct groups. There were four species of *Camponotus* in attendance, namely *C. consobrinus* (Erichson) (28 colonies), *C. nigriceps* (Smith) (1 colony), *C. eastwoodi* McArthur (1 colony) and *C. intrepidus* (Kirby) (8 colonies), with one unattended. *O. genoveva* and *O. zosine* early stages were also investigated at sites throughout Queensland, New South Wales and the Northern Territory.

Observations on the "gallery"

Various authors describe *O. genoveva* and *O. zosine* larvae sheltering in the "ants' nest" (Common and Waterhouse 1981, D'Abrera 1971, Fisher 1995, Kitching 1991, Nielsen and Common 1991) whilst McCubbin (1971) and Fisher (1978) describe the situation as ant "galleries". During the course of this investigation, over 100 colonies of *O. genoveva* and 40 colonies of *O. zosine* were examined. It was noticed that the *Ogyris* larvae were not

sheltering in the ants' "nest", ie. "a place used by insects....or the like for depositing their eggs or young" (Macquarie English Dictionary). The ants' nest was always located separately and sometimes quite a distance (5 m or more) from the "gallery" prepared by ants for the *Ogyris* larvae. In situations where the ants' nest was located near the base of the tree, *O. genoveva* larvae were kept in their specially prepared galleries well away from the ant brood. Therefore, it is suggested that the correct term to describe the excavated cavity where *Camponotus* ants attend *O. genoveva* and *O. zosine* larvae should be "gallery".

Both species of *Ogyris* shelter in naturally occurring situations such as borer holes, including those made by *Endoxyla* spp. (Lepidoptera: Cossidae), under suitable slabs of bark (Waterhouse 1913, Kitching 1991), in hollow branches and tree trunks (Waterhouse and Lyell 1908, McCubbin 1971, Le Souëf 1976), or even in an abandoned bird's nest (J. Olive, pers. comm.). Both *Ogyris* spp. larvae utilise these natural situations when available (see also DeBaar 1994), even when colonies on nearby trees are in galleries and soil conditions are suitable.

Camponotus ants were occasionally found renovating old galleries or constructing new ones without larvae present. Presumably there were eggs on the tree or small larvae on the mistletoes because on subsequent examination *O. genoveva* larvae were present in the gallery. The ants may excavate a number of chambers in the gallery that are not used by *O. genoveva* larvae. Some of these vacant chambers are later occupied by *O. genoveva* pupae, while others are sealed off and may contain dead *O. genoveva* larvae (see also McCubbin 1971). Galleries are usually around 15-20 cm deep but may be deeper (e.g. 30 cm or more).

In North Queensland, *O. zosine* larvae were observed attended by *C. subnitidus* Mayr, which nests in hollow branches or constructs an arboreal nest using accumulated debris. However, the ants still constructed galleries at the base of the tree for immature *O. zosine*. Many of these galleries were different from those constructed for *O. genoveva*, being closer to the surface and assembled with more cemented material such as leaves, rolled bark and other deposits. Gallery design varied according to terrain, weather conditions and available materials and, to a lesser extent, the ant species.

Ant behaviour

Of the four species of sugar ant encountered in the study site near Grafton, the behaviour of *C. intrepidus* was studied most thoroughly. It is a robust, easily provoked ant, with majors capable of inflicting a painful bite. *C. intrepidus* is darker than most other species of *Camponotus*, having a red-brown to black head, deep red-brown thorax and black abdomen. When there are thousands of these ants guarding a large colony of *O. genoveva* they can be quite a daunting adversary to any creature looking for an easy meal.

Some *Camponotus* ant species are not openly aggressive, even when handled. By contrast, *C. intrepidus* were observed to quickly attack or repel arthropod predators or intruders such as tree crickets (Orthoptera: Gryllacrididae) or huntsman spiders (Araneida: Sparassidae). When danger threatens, ants herd *O. genoveva* larvae to the lower levels in the gallery by gently nipping the larvae to encourage them to move, occasionally picking them up or dragging them down the gallery. Significant disturbances can result in dramatic behavioural changes, whereby both *C. intrepidus* and *C. consobrinus* fiercely attack anything that interferes with the gallery. While in this aggressive state, *Camponotus* ants will even bite and kill dislodged *O. genoveva* and *O. zosine* pupae or larvae. Such ant frenzy is very short lived. By contrast, *C. nigriceps* and *C. eastwoodi*, when threatened, appeared to scatter and seek shelter. This passive behaviour was reflected in the higher rate of parasitism by braconid wasps, 100% (all 7 larvae) in the small colony attended by *C. eastwoodi*. Parasitism rate in the largest *C. intrepidus* attended colony was about 5% (8 out of approximately 150). Turner and Hawkeswood (1992) noted a parasitism rate of 32% in two colonies of *O. genoveva* attended by *C. consobrinus*.

Meat ants *Iridomyrmex purpureus* (Fr. Smith) prey upon the larvae of *Ogyris* (Samson and O'Brien 1981, Thorn 1924) and, when meat ants are present, less aggressive *Camponotus* species such as *C. nigriceps* and *C. eastwoodi* will reduce the size of the gallery entrance to a hole just big enough for two majors' heads to block and defend against any intruder. Occasionally *C. nigriceps* and *C. eastwoodi* completely seal up the gallery entrance with cemented soil and debris, especially when meat ants threaten, or sometimes during wet weather. *C. intrepidus* was not observed to be harassed by meat ants nor did they close their gallery entrance.

Any ants that die or any other ant intruders that are killed are carried some 10-15 cm away from the gallery entrance and dumped. A small dark species of ant (unidentified) was observed to take advantage of the graveyard food source by setting up a nest in close proximity to the *O. genoveva* gallery entrance. *O. genoveva* larval frass is similarly removed from the gallery (see Burns and Rotherham 1969). Frass is grabbed as it is being expelled, even when the *O. genoveva* larvae are feeding. At this point larval frass is usually carried a short distance and dropped.

Most food collected on the host tree by *Camponotus* ants is taken directly back to the ants' nest. However, when termites are swarming the ants have been observed to store a small number of them in an unoccupied gallery.

At Eatonsville, *C. intrepidus* construct their nest on exposed ground and cover the entrance during the day with cemented soil and debris. About an hour before sunset the nest entrance is opened and ant activity increases until after dark when ants can be seen foraging over a wide area. Peak ant activity is just after dark, when a constant stream of ants can be seen moving from the

nest across the ground into the gallery and from there up the tree. Initially, ant scouts proceed up the tree to the mistletoe well ahead of *O. genoveva* larvae, clearing off any predators along the way. Ants regularly stand guard on either side of the *O. genoveva* larval procession up the tree and especially on the return journey. Less attention is paid to the small larvae while larger larvae are constantly attended, with ants incessantly touching and stroking over the entire dorsal surface of the larvae with their antennae. Ants have also been observed gently pressing their open mandibles onto the dorsal ridge of larger *O. genoveva* larvae and riding on the backs of larvae as they crawl up the tree. Ants continually occupy the gallery even when all *O. genoveva* larvae are out feeding. On one occasion, ants from two *C. intrepidus* nests (presumably a polydomous colony) were observed entering the same gallery to attend *O. genoveva* larvae.

Ogyris larval behaviour

Ogyris genoveva larvae accumulate just inside the gallery entrance before dusk until the light level is sufficiently reduced for them to proceed. First and second instar larvae usually emerge first, heading straight up the tree, while some of the larger larvae linger outside the gallery entrance before continuing. Most *O. genoveva* larvae have emerged from the gallery within the first hour after sunset, with stragglers continuing to move up the tree until around 2130h EST. Larvae always follow the same route up the tree while laying down a fine silk thread and in larger colonies this trail can be clearly visible (Common and Waterhouse 1981). The larvae begin returning to the gallery around 0200h EST and continue until just after sunrise, with the majority returning before dawn.

Whenever *O. genoveva* and *O. zosine* larvae are active, either in transit or feeding, their tentacular organs are repeatedly everted (Samson 1987) whilst being attended by the ants. Ballmer and Pratt (1991) noted that the eversible organs apparently release chemicals which mimic ant alarm pheromone(s), inducing heightened activity and aggressive posturing in the attendant ants. However, these tentacular organs are rarely everted by *O. genoveva* or *O. zosine* larvae when they are in the gallery. This observation lends support to Ballmer and Pratt's contention, since *Ogyris* larvae would not require an aggressive response inside the gallery. Inside the gallery individual ants, in a torpid condition, often stand astride a pupa or larva and continuously monitor the pupal or larval extremities with their slowly moving antennae.

First instar *O. genoveva* larvae are often found in the gallery with other instars (they are easily overlooked). However, when the soil is waterlogged or when other ant species dominate the substratum, most smaller *O. genoveva* larvae group together under the base of the mistletoe while larger larvae shelter opportunistically in suitable situations.

To account for large numbers of *Ogyris* in a gallery it has been suggested that the ants may collect young *Ogyris* larvae from several trees and bring them

to a single gallery (Common and Waterhouse 1981). This was not observed during the study and is thought to be unlikely. Some large *O. genoveva* and *O. zosine* colonies may be surrounded by trees with separate colonies, often with a different species of *Camponotus* in attendance. In addition, a gallery of more than 200 individuals of *O. genoveva* and an abandoned bird nest containing more than 250 individuals of *O. zosine* have been observed in situations completely isolated from other trees. It is more likely that large larval numbers result from *Ogyris* females being drawn to a particular mistletoe by the presence of ants or other oviposition cues. Conversely, in the wet season, there are sometimes a larger number of host trees utilised by *O. genoveva,* each with only very small numbers of larvae (ca. 1-4) present. *O. genoveva* larvae are usually found under the bark at this time but in well drained areas will be found in small galleries at the base of the tree (see also Atkins 1993).

Ogyris genoveva larvae do not feed gregariously but spread out all over the mistletoe, feeding on the edges of the leaves and on new shoots. They feed for short periods punctuated by occasional intervals on the mistletoe stem. If mistletoe leaves are in short supply, larvae will eat the bark off the mistletoe stems.

Pupation usually occurs close to the entrance, within the gallery, on hard surfaces such as the tree trunk, on the sides of or under rocks or on partly buried bark. If suitable pupation sites are not available near the surface *Ogyris* will pupate further down under the tree roots. Destruction of *O. genoveva* pupal shells after emergence as reported by Common and Waterhouse (1981) was not observed, however, very few *O. genoveva* pupal remains were found.

Ogyris genoveva and *O. zosine* adults were mostly observed to emerge between 0730-0930h EST. The imago moves slowly after emerging from the pupa and expands its wings inside the gallery. Ants continue to monitor the almost motionless adult by gently tapping it alternately with their antennae. The attendant ants are generally in a very quiescent state but will occasionally crawl over the head and expanding wings of the motionless butterfly. When the butterfly's wings have hardened it walks slowly, stopping momentarily when approached by an ant, until it emerges from the gallery entrance. In confined pupation sites (eg in borer holes or under bark), the imago expands its wings as close as possible to the exit, usually in the company of ants. Ants vacate the gallery after all *O. genoveva* adults have emerged.

Unattended larvae or pupae were observed on three occasions. A single pupa was found under bark at Leyburn, Qld. One prepupal and one first instar *O. genoveva* larva were found sheltering under bark in the study area at Eatonsville, close to three *O. oroetes* Hewitson pupae being attended by a *Crematogaster* sp. ant. Similarly, an unattended pupa of *O. zosine* together

with numerous empty pupal shells was found under bark at Woodstock, west of Townsville, Qld.

Discussion

Ogyris genoveva and *O. zosine* larvae benefit greatly from their association with the *Camponotus* ants. The ants are constantly attending the larvae or actively patrolling close by, protecting their symbionts from predators and parasitoids. In addition, ants expend enormous amounts of energy preparing and maintaining the galleries. The larvae of both *Ogyris* spp. appear to manipulate the degree of protection and attention that the ants bestow on them by regulating the release of chemicals from their tentacular (and other) organs according to their needs. However, studies have shown that the ants too profit from the association (see Fiedler and Saam 1995, Cushman *et al.* 1994, Pierce *et al.* 1987).

The ultimate survival of *O. genoveva* and *O. zosine* is, probably, dependent upon the attendant ants, for without them the larva would be exposed to formidable pressures from predators, parasitoids and the environment.

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